# Year 2 (2003) Monitoring Report for Commencement Bay Habitat Restoration Sites

Prepared for the

Commencement Bay
Natural Resource Damage Assessment
and Restoration Trustees

# YEAR 2 (2003) MONITORING REPORT FOR COMMENCEMENT BAY HABITAT RESTORATION SITES

Prepared for the

Commencement Bay

Natural Resource Damage Assessment and Restoration Trustees

Prepared by

RIDOLFI Inc.

and

Adolfson Associates, Inc.

December 2003

## EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) is the lead agency of the Commencement Bay Natural Resource Trustees (Trustees) and is responsible for managing restoration projects under the Commencement Bay Natural Resource Damage Assessment and Restoration program. In 2000, the Trustees prepared a Restoration Monitoring Plan for Commencement Bay in order to measure the success of restoration efforts, identify adaptive management approaches if projects are not achieving goals, address monitoring requirements specified by permitting agencies, and serve as an outreach tool to disseminate project information to interested parties.

Under the direction of NOAA, Ridolfi Inc. conducted Year 2 (2003) monitoring at seven habitat restoration sites around Commencement Bay, in Tacoma, Washington. The seven sites are Mowitch, Squally Beach, Skookum Wulge, and Yowkwala along the Hylebos Waterway and the eastern edge of Commencement Bay and Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), and Olympic View along the Middle Waterway.

Three physical success criteria and nine biological success criteria were monitored in various combinations at the different sites to evaluate physical stability, marsh development, riparian vegetation, fish access and presence, invertebrate prey resource production, and bird use. Not all criteria were required to be monitored at all sites in 2003. Table ES-1 summarizes the performance at each site to date.

**Table ES-1. Performance summary for Year 2 (2003) monitoring.**

| | Physical Success Criteria | | | | Biological Success Criteria | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Site Name** | Intertidal Areal Coverage | Intertidal Stability | Tidal Circulation | Elevation and Channel Morphology | Marsh Development/Areal Coverage | Marsh Development/Species Composition | Marsh Development/Plant Vigor | Marsh Development/Herbivory Avoidance | Riparian Vegetation Survival | Riparian Vegetation/Areal Coverage | Fish Access/Presence | Invertebrate Prey Resource Production | Bird Use |
| Mowitch | | Y | Y | Y | Y | N | + | Y | Y | + | Y | ?[1] | Y |
| Squally Beach | | Y | | Y | Y | N | + | Y | Y | + | | | Y |
| Middle Waterway (Simpson/Trustees) | | | | Y | Y | Y | | Y | | + | Y | ?[1] | Y |
| Middle Waterway (City of Tacoma) | | Y | | N | | | | | | | Y | ?[1] | |
| Yowkwala | | | | | ?[2] | | | | | | Y | ?[1] | |
| Skookum Wulge | | | | | | | | | | | Y | ?[1] | |
| Olympic View | | | | | | | | | | | Y | | |

**Notes:**
Y = Criterion met
+ = Criterion not met but improving
N = Criterion not met, no trend assessed
? = Results not yet available
[1] Will be the subject of a separate report
[2] First year of monitoring; assessing progress will require comparison to subsequent monitoring phases

Overall results indicate that the restoration efforts are on a positive trajectory. Riparian and marsh plant communities are developing at the sites where plants were installed. The sites are relatively stable, suggesting that appropriate hydrological conditions, as controlled by the tides, should continue into the future. Some key actions suggested for adaptive management and improved monitoring include:

- Placing cobbles in a developing rill at the Squally Beach site and redirecting the water across the marsh bench to the west, creating a longer, slower flow path.

- Designing erosion protection measures for the Middle Waterway (City of Tacoma) site.

- Planting additional trees and shrubs at the Mowitch site to meet requirements for riparian vegetation survival.

- Providing additional weed control at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites to reduce non-native/invasive plant encroachment in both riparian and marsh areas.

- Controlling encroaching non-native/invasive plants along the eastern side of the Squally Beach site to ensure that these plants do not take over the planted riparian areas.

- Removing garbage that has accumulated on some of the sites, not only for aesthetic reasons, but also to increase the potential for new vegetation to establish and to increase the habitat value for wildlife.

- Conducting future fish monitoring events weekly from early March to late June. This would increase the chances of documenting the peak migration of salmonids.

- Using the beach seine net for fish monitoring at the Middle Waterway (City of Tacoma) site instead of the block net, as it will be more effective for the location and result in less harm to the fish.

- Using fyke nets, live boxes, or other fishing methods at the Mowitch site instead of block nets to reduce fish trauma and death and achieve more accurate sampling.

- Determining an allowable percentage of daily salmonid catch to be taken for chemical analysis, so that the total catch of salmonids is not taken when salmonid presence is low.

## TABLE OF CONTENTS

## LIST OF APPENDICES



## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| Adolfson | Adolfson Associates, Inc. |
| BSC | biological success criterion |
| cm | centimeter |
| Champion | Champion International Corporation |
| CHB | Citizens for a Healthy Bay |
| CPUE | catch per unit effort |
| CWT | coded wire tag |
| EPA | United States Environmental Protection Agency |
| FL | fork length |
| ft | foot or feet |
| ha | hectare |
| in. | inch or inches |
| m | meter |
| MHHW | mean higher high water |
| MHW | mean high water |
| MLLW | mean lower low water |
| MLW | mean low water |
| mm | millimeter |
| msl | mean sea level |
| NOAA | National Oceanic and Atmospheric Administration |
| NOAA Fisheries | National Marine Fisheries Service, National Oceanic and Atmospheric Administration |
| NOS | National Ocean Service |
| PSC | physical success criterion |
| rebar | reinforcing steel bar |
| Simpson | Simpson Tacoma Land Company |
| sp. | species |
| SR | species richness |
| Trustees | Commencement Bay Natural Resources Trustees |
| WDFW | Washington Department of Fish and Wildlife |

## 1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) issued Task Order No. T0009 under Contract 50ABNF-2-003 to Ridolfi Inc. (Ridolfi) to conduct Year 2 (2003) monitoring activities at seven habitat restoration sites on Commencement Bay, in Tacoma, Washington (Figure 1-1). NOAA is the lead agency of the Commencement Bay Natural Resource Trustees[1] (Trustees) and is responsible for managing restoration projects under the Commencement Bay Natural Resource Damage Assessment and Restoration program.

The Trustees prepared a Restoration Monitoring Plan for Commencement Bay (Trustees, 2000). The Trustees' planning document identified several purposes of the monitoring program:

- To measure the success of the restoration efforts;
- To identify adaptive management approaches if projects are not achieving goals;
- To address monitoring requirements specified by permitting agencies; and
- To serve as an outreach tool to disseminate project information to interested parties.

This report describes the Year 2 (2003) monitoring activities, presents the results of the field work, assesses progress toward meeting the physical and biological success criteria identified for the project, and recommends adjustments (adaptive management) for future monitoring years. Ridolfi personnel, with support from Adolfson Associates, Inc. (Adolfson), collected most of the monitoring data. Staff from the National Marine Fisheries Service (NOAA Fisheries) also conducted monitoring in conjunction with Ridolfi staff. NOAA scientist Alex von Saunders collected the invertebrate data. Photo points were documented by volunteers from Citizens for a Healthy Bay (CHB), and CHB volunteers also worked on data entry.

Appendices contain detailed tables presenting the Year 2 monitoring data (Appendix A); a photographic record of some fish monitoring activities (Appendix B); a description of the method employed to calculate vegetation coverage (Appendix C); complete field reports for the

[1] The Commencement Bay Natural Resource Trustees consist of the following entities: the National Oceanic and Atmospheric Administration; the U.S. Fish and Wildlife Service; the Washington State

fish monitoring (Appendix D); and the photo point documentation collected by CHB (Appendix E). The results of the invertebrate monitoring will be published separately by NOAA.

## 1.1 Site Descriptions

The seven restoration sites where monitoring occurred are briefly described below. Originally, eight sites were to be monitored. However, the Tahoma Salt Marsh site, which was monitored during the Year 1 effort, was omitted from the Year 2 effort because it has not yet been restored.

### 1.1.1 Mowitch

The Mowitch site, previously known as the Wasser/Winter site or Hylebos Estuary site, is at the junction of Hylebos Creek and the southeast end of the highly industrialized Hylebos Waterway on land owned by the Port of Tacoma (Figure 1-1). The site is approximately 2.3 acres (0.9 hectare [ha]) in area and includes Hylebos Creek and an adjacent strip immediately northwest of the creek that is approximately 100 feet (ft) (30 meters [m]) in width and 1,000 ft (300 m) in length. The site is bounded on the south by the centerline of the Hylebos Creek; on the west by a railroad right-of-way adjacent to Marine View Drive; on the north by an 8-ft (2.4-m) cedar fence; and on the west by the pier headline at the southeast end of the Upper Hylebos Waterway turning basin.

The elevation of the upland portion of the site is approximately 6 to 12 ft (1.8 to 3.7 m) above mean sea level (msl) or 12 to 18 ft (3.7 to 5.5 m) above mean lower low water (MLLW). The site includes the north half of Hylebos Creek, which prior to restoration passed through the site in a straight, deep, steep-banked channel. The site formerly sloped slightly toward the creek and the Hylebos Waterway and included a log ramp at its northwest end.

From June through October 2000, a restoration effort was conducted on behalf of the Trustees under the direction of NOAA. Three backwater pools with base elevations near mean low water (MLW) were sculpted from the existing upland buffer. The backwater areas are flooded twice each day. A secondary stream mouth was added at the location of the historical log ramp.

---

Department of Ecology; the Washington State Department of Fish and Wildlife; the Washington State Department of Natural Resources; the Puyallup Tribe of Indians; and the Muckleshoot Indian Tribe.

The pools and adjacent terraces include horizontal logs as habitat features. In addition, the area between the pools was regraded to an elevation between mean high water (MHW) and mean higher high water (MHHW) (10.96 to 11.84 ft [3.34 to 3.61 m] on an MLLW datum). A buffer of 25 ft (7.6 m) next to the fence remained vegetated. Large woody debris was placed, and the upland areas of the site (elevation above 14 ft [4.3 m] MLLW) were hydroseeded with a mix of native grasses and forbs. Volunteers planted native plants, shrubs, and trees in the fall of 2000 and spring of 2001. Following initial monitoring, several hundred individual potted plants were installed in a replanting event initiated in November 2002. Organic-rich topsoil was placed around each of the new plants to improve the chances of successful plant establishment.

### 1.1.2 Squally Beach

The Squally Beach site, previously known as the Puyallup Tribal Nursery site or the Puyallup Tribal Conservancy and the Inner Hylebos site, is located along the northern shoreline of the Hylebos Waterway, south of Marine View Drive and immediately west of East 11th Street (Figure 1-1). The site consists of approximately 0.66 acre (0.27 ha) of uplands bordering an extensive area of intertidal mudflats immediately west. The Squally Beach site is adjacent to the largest expanse of original mudflats in Commencement Bay. The site contains salt marshes and low-gradient mudflats that provide habitat for benthic organisms important to the food chain. These organisms are of particular importance to shorebirds and juvenile salmon.

Prior to restoration, the Squally Beach site contained some hardwood trees, blackberry bushes, and a strip of intertidal marsh vegetation approximately 3 to 4 ft (0.9 to 1.2 m) in width growing at approximately MHHW elevation. The upland portion of the site was covered with blackberry bushes and other invasive plants and used as a dump. The site contained several pilings, logs, and downed wood, indicative of previous log storage in the vicinity.

The restoration design was consistent with the overall objective for the Hylebos Waterway of increasing the sinuosity of the shoreline and increasing the area and quality of the intertidal habitat. The design phase was completed in late 1999, construction was completed in the fall of 2000, and vegetation planting of the upland took place in fall 2000 and spring 2001.

The restoration project involved excavating about 2,000 cubic yards of material, grading an area north of the existing vegetation line, and planting intertidal vegetation. Runoff from the hillside on the north side of Marine View Drive, which forms the eastern project boundary, was intercepted and routed through the project site in a dendritic channel pattern. Freshwater inputs were used to lower salinity and encourage growth of saltwater marsh species that tolerate brackish conditions. The site was hydroseeded with a mix of native species, and native plants, shrubs, and trees were hand-planted by volunteers. Initial monitoring indicated that riparian vegetation at Squally Beach was dominated by sweet clover. Volunteers arranged a weed-pulling event to manage this species, followed by in-fill planting in November 2002.

### 1.1.3 Middle Waterway (Simpson/Trustees)

The Middle Waterway (Simpson/Trustees) site is a 3.3-acre (1.3-ha) nearshore area. The site is on property owned by Simpson Tacoma Land Company (Simpson) in a highly industrialized area at the southeast end of the Middle Waterway (Figure 1-1). The site is in proximity to and functionally related to the intertidal habitat constructed in 1988 as part of the St. Paul Waterway Area Remedial Action and Habitat Restoration Project conducted by Simpson and Champion International Corporation (Champion) (now International Paper Company) at the north end of the Tacoma Kraft mill, as well as to other intertidal and subtidal areas near the Puyallup River delta.

Under the St. Paul Waterway Natural Resource Damage settlement agreement, Simpson and Champion funded the Middle Waterway Shore Restoration Project, which was selected and proposed by a project planning group consisting of Simpson, Champion, the Trustees, and other cooperating federal and state agencies. The primary objective of the project was to provide estuarine habitat in perpetuity adjacent to one of the largest remaining areas of original Commencement Bay intertidal mudflat. Under the settlement agreement, monitoring was initiated at the site in 1994, prior to construction, and continued through the summer of 2000. Construction was initiated in early 1995, and planting was undertaken between October 1995 and May 1996. In the summer of 1999, the Trustees assumed management responsibility for the site. In the fall, the Trustees put into practice adaptive management techniques to promote the

establishment of intertidal vegetation by regrading a portion of the site and by adding organic soil amendments, followed by supplemental planting in the spring of 2000.

Lower elevations at the site are functioning as mudflat habitats with patchy but extensive cover of microalgae, macroalgae, and a few species of vascular plants. These species generate primary production and organic matter (detritus) that are consumed by bacteria and primary consumers (herbivores and detritivores). The primary consumers in turn provide food for secondary consumers such as benthic invertebrates, juvenile salmon, flatfish, and shorebirds. Buffer and riparian vegetation planted at the site is surviving but physical and biological stresses, including high salinity, sandy soils, wave action, and herbivory by geese, have hampered the establishment of mid- and upper-intertidal vegetation. Adaptive management measures have been undertaken by the Trustees to ameliorate some of these stresses.

### 1.1.4 Middle Waterway (City of Tacoma)

As part of the City of Tacoma's settlement agreement, the City developed an estuarine shoreline wetland restoration project on the Middle Waterway within the City of Tacoma and Commencement Bay (Figure 1-1). The project is across the head of Middle Waterway from and complements the Middle Waterway (Simpson/Trustees) site. The site is composed of three contiguous parcels, designated as the City parcel, the DNR parcel, and the 11$^{th}$ Street right-of-way.

Excavation and regrading of the 1.85-acre (0.75-ha) vacant upland property, which is adjacent to and within the southwest shore of the waterway, created an intertidal marsh and riparian buffer bordering one of the few remaining original mudflats within Commencement Bay. The project objectives are to create new habitat, enhance existing habitat, provide buffers for both new and existing habitat, and provide public access for education and passive recreation. The project goal is to establish estuarine marsh habitat for an assemblage of wetland-dependent marine, bird, and plant species.

### 1.1.5 Yowkwala

The Yowkwala site, which is approximately 15 acres (6 ha) in size, is between the Tyee Marina and Browns Point (Figure 1-1). Restoration at this site consisted of a beach cleanup conducted in March 2000.

The beach cleanup involved demolishing and disposing of two derelict wooden barges stranded on the shoreline and removing debris from one former dry dock and a sunken concrete float. The barges were demolished on site using minimal construction equipment, then hauled away via an existing access road. The demolition occurred at low tide to minimize risks or impacts to the marine environment. The majority of the wood debris was chipped and recycled rather than transported to a landfill.

### 1.1.6 Skookum Wulge

The Skookum Wulge site, formerly known as the Meeker site, is on a parcel just outside of the mouth of the Hylebos Waterway that is owned by the Puyallup Tribe (Figure 1-1). The site, which covers less than 1 acre (under 0.4 ha), is bounded by Marine View Drive to the northeast and residential properties to the southeast and northwest. The site was reportedly occupied by a residential structure until the mid-1930s, when a landslide from the steep, undeveloped, wooded hillside adjacent to Marine View Drive, which rises to approximately 400 ft (120 m) above msl, swept the structure into Commencement Bay. The site has been undeveloped since that time.

The site slopes gently from Marine View Drive toward Commencement Bay. A low, steep, erosional bluff, approximately 2 to 4 ft (0.6 to 1.2 m) in height, separates the upland portion of the site from the beach below. The upland area is semicircular and protrudes approximately 100 ft (30 m) toward the southwest into Commencement Bay. This landform is apparently the remnant of the landslide. The steep face at the edge of the upland area seemingly indicates that wave action is eroding the face and cutting back toward Marine View Drive.

The beach below the upland bluff is composed of gravel and cobble-sized materials similar to materials present in the exposed bluff. The beach grades uniformly toward the benthic

environment in a radial pattern that is consistent with erosion from a relatively recent landslide. The beach slopes at approximately 10 to 12 percent away from the bluff.

In 1999, the Trustees evaluated restoration alternatives for the Skookum Wulge site and decided that site conditions made the "no-action" alternative preferable.

### 1.1.7 Olympic View

The Olympic View project included the City of Tacoma's acquisition of 0.7 acre (0.3 ha) of upland and intertidal property bordering the 11.7-acre (4.7-ha) lease site of state-owned aquatic lands (Figure 1-1). The lease precludes use of the eelgrass areas for incompatible commercial or industrial purposes. A building owned by the now-defunct Puget Sound Plywood Company and extending over private and state-owned intertidal lands was partially removed to allow the re-establishment of a productive community of tidal species. In June through September 2002, the United States Environmental Protection Agency (EPA) managed in-water work through the remedial process that included removing dioxin-contaminated sediments and backfilling the excavation with clean sediments. The pilings were removed and the site was prepared for restoration, including softening the shoreline to enhance the intertidal habitat and create a riparian buffer.

The project goal is to protect and enhance nearshore eelgrass and intertidal habitat for an assemblage of aquatic species in a manner consistent with low-impact public use and enjoyment of a shoreline and water areas.

## 2.0 DESCRIPTION OF FIELD ACTIVITIES

This section describes the procedures used to evaluate the restoration sites. The field work was performed according to the schedule outlined in the work plan for the project (Ridolfi and Adolfson, 2001). Table 1 summarizes by site the physical success criteria (PSC) and biological success criteria (BSC) evaluated during the Year 2 (2003) monitoring.

**Table 1. Monitoring conducted in Year 2 (2003) by site and parameter.**

| | **Physical Success Criteria** | | | | **Biological Success Criteria** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| **Site Name** | Intertidal Areal Coverage | Intertidal Stability | Tidal Circulation | Elevation and Channel Morphology | Marsh Development/Areal Coverage | Marsh Development/Species Composition | Marsh Development/Plant Vigor | Marsh Vegetation Herbivory Avoidance | Riparian Vegetation Survival | Riparian Vegetation/Areal Coverage | Fish Access/Presence | Invertebrate Prey Resource Production | Bird Use |
| Mowitch | | X | X | X | X | X | X | X | X | X | X | X | X |
| Squally Beach | | X | | X | X | X | X | X | X | X | | | X |
| Middle Waterway (Simpson/Trustees) | | | | X | X | X | | X | | X | X | X | X |
| Middle Waterway (City of Tacoma) | | X | | X | | | | | | | X | X | |
| Yowkwala | | | | | X | | | | | | X | X | |
| Skookum Wulge | | | | | | | | | | | X | X | |
| Olympic View | | | | | | | | | | | X | | |

The monitoring tasks performed to assess progress toward the PSC and BSC goals are described below.

## 2.1 Physical Success Criterion 1 – Intertidal Areal Coverage

---

**INTERTIDAL AREAL COVERAGE.** *The total restored area between an elevation of +12 ft (+3.7 m) NOS MLLW and –2 ft (–0.6 m) MLLW will be at least 90 percent of the target intertidal elevation.* (From Ridolfi and Adolfson, 2001.)

---

Intertidal area is an important measure of available habitat at restoration sites. For many of the sites in Commencement Bay, one of the project goals is to increase the intertidal area. This criterion was not scheduled for monitoring at any site during Year 2.

## 2.2 Physical Success Criterion 2 – Intertidal Stability

---

**INTERTIDAL STABILITY.** *The as-designed contour elevations, especially for intertidal plant introductions, will be +/– 0.5 ft (0.15 m) of the elevations specified in the construction plan. 75 percent of the target elevations will be maintained through Year 5.* (From Ridolfi and Adolfson, 2001.)

---

This criterion focuses on potential changes at sites within the elevation band where most marsh vegetation grows. This band is in the upper tidal ranges near and above the MHW line. As used in this report, intertidal area is defined as the area between the –2 ft (–0.6 m) and +12 ft (+3.7 m) contours as measured in acres or other appropriate units. The vertical datum for the project is MLLW as reported by the U.S. Army Corps of Engineers. Important tidal datums in Commencement Bay are shown in Table 2.

**Table 2. Relationship between vertical datums in Commencement Bay.**

| Datum Plane | MLLW | | NGVD 29 | |
|---|---|---|---|---|
| | (feet) | (meters) | (feet) | (meters) |
| Highest Estimated Tide | 15.50 ± 0.5 | 4.72 ± 0.15 | 9.18 ± 0.5 | 2.80 ± 0.15 |
| Mean Higher High Water | 11.84 | 3.61 | 5.52 | 1.68 |
| Mean High Water | 10.96 | 3.34 | 4.64 | 1.41 |
| Mean (Half) Tide Level | 6.91 | 2.11 | 0.59 | 0.18 |
| NGVD 29 | 6.32 | 1.93 | 0 | 0 |
| Mean Low Water | 2.86 | 0.87 | -3.46 | -1.05 |
| Mean Lower Low Water | 0 | 0 | -6.32 | -1.93 |
| Lowest Estimated Tide | -4.50 ± 0.5 | -1.37 ± 0.15 | -10.82 ± 0.5 | -3.30 ± 0.15 |

**Notes:**
MLLW: mean lower low water
NGVD 29: National Geodetic Vertical Datum of 1929
**Source:** U.S. Army Corps of Engineers webpage: <http://www.nws.usace.mil/hh/tides/sp/spgo.htm>

To evaluate intertidal stability, the locations of contours at specified elevations were measured at the Mowitch, Squally Beach, and Middle Waterway (City of Tacoma) sites. Ridolfi used a Topcon GTS-815A total station instrument, equipped with a TDS Recon datalogger, to obtain horizontal coordinates of the +8, +10, +12, and +13.5 ft (+2.4, +3.0, +3.7, and +4.1 m) MLLW contours at approximately at 20-ft (6-m) intervals. In addition, the total station instrument was used to measure coordinates along the transects employed for BSC 2 and BSC 5 monitoring.

The horizontal area covered by each band of intertidal elevation (e.g., –2 to +8 ft [–0.6 to +2.4 m], –2 to +10 ft [-0.6 to +3.0 m], etc.) was calculated and compared to the baseline values to verify whether the percent change in elevations met the requirements of PSC 2.

### 2.3 Physical Success Criterion 3 – Tidal Circulation

***TIDAL CIRCULATION.*** *The tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area.* (From Ridolfi and Adolfson, 2001.)

This task is intended to evaluate whether tidal circulation is similar inside and outside the project area. Differences in tidal circulation could arise if debris or slumping soil blocked a channel. Given the relatively small size of each site and the lack of potential flow restrictions, this task did not require separate monitoring. Instead, the visual observation of flow restrictions, if any, was noted while performing other monitoring tasks at the Mowitch site (the only site monitored for this criterion).

### 2.4 Physical Success Criterion 4 – Elevation and Channel Morphology

---

***ELEVATION AND CHANNEL MORPHOLOGY.*** *No evidence of erosion that threatens restoration project goals, property, infrastructure, or is otherwise unacceptable is observed after a period of initial site stabilization.* (From Ridolfi and Adolfson, 2001.)

---

Visual observations and cross-sectional surveys were used to evaluate channel elevations and morphology. Surveys were conducted along permanent cross sections at the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), and Middle Waterway (City of Tacoma) sites. In areas between cross sections, observations were made regarding erosion or other morphological changes. Six to ten cross sections were surveyed per site. So that cross sections can be identified in subsequent years, reinforcing steel bars ("rebar") capped with protective plastic covers were driven at the ends of the cross sections. Ridolfi used the total station instrument to obtain horizontal and vertical coordinates along the selected cross sections.

### 2.5 Biological Success Criterion 1 – Marsh Development/Areal Coverage

---

**MARSH DEVELOPMENT/AREAL COVERAGE.** *The areal extent (percent cover) of vegetation should be stable or increasing within portions of the project within elevations suitable to marsh establishment.* (From Ridolfi and Adolfson, 2001.)

---

Adolfson staff mapped the extent of marsh vegetation in mid-summer. Stake-wire flags were placed around areas of dominant marsh vegetation (i.e., areas in which the percent cover of marsh vegetation was at least 25 percent). Ridolfi personnel subsequently used the total station instrument to obtain coordinates for the flags. Mapped areas represented on the vegetation figures are at least 4 $ft^2$ (0.4 $m^2$) in size.

Mapped areas were given unique two-letter labels (e.g., MA, MB). The first letter, either "R" or "M," denotes either riparian or marsh; the second letter was assigned sequentially beginning with "A" as vegetated areas were mapped. For each mapped area, which may be either a point or a polygon, the overall percent cover of the vegetation and the dominant species were estimated visually and recorded by Adolfson staff biologists.

This monitoring task was conducted at the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), and Yowkwala sites. The City of Tacoma monitored the Middle Waterway (City of Tacoma) site.

### 2.6 Biological Success Criterion 2 – Marsh Development/Species Composition

---

**MARSH DEVELOPMENT/SPECIES COMPOSITION.** *Species composition of native wetland/emergent plant species should be comparable to that of appropriate reference or comparison sites. If planted, survival should reach or show a trend toward 50 percent by Year 3. The project should not contain more than 5 percent cover by area of non-native or invasive plant species. Invasive plant species of special concern include, but are not limited to,* Spartina *spp. (cordgrass),* Lythrum salicaria *(purple loosestrife),* Phalaris arundinacea *(reed canarygrass), and* Phragmites communis *(common reed).* (From Ridolfi and Adolfson, 2001.)

---

In mid-summer, plant species composition was evaluated within the marsh area along transects using randomly placed quadrats ("quadrats" are plots, usually rectangular, used for ecological or population studies). Transects were positioned along contours to achieve a stratified random

approach. Adolfson staff biologists recorded the presence and percent cover of marsh species within each quadrat. These data were then tabulated and compared with planting plans and the Year 3 general restoration goal of reaching or trending toward 50 percent cover by target vegetation. In addition, it was noted whether non-native and invasive plant species composed more than 5 percent of the vegetation cover.

Permanent transects were established generally along contours at each site monitored. Most of the transects had been installed prior to the Year 1 (2002) monitoring and were positioned to capture the areal extent of marsh vegetation as well as to characterize the plant community. Rebar was used to permanently mark the transect locations. The number and location of quadrats along each transect were established based on a random statistical approach identified in the work plan. A new transect was added this year on the Squally Beach site to capture the lower marsh vegetation. In addition, a new transect was added on the Mowitch site to characterize marsh vegetation on three lobes of intertidal habitat.

A random number table was used to determine the sampling locations. The total number of sampling points was based on the number and length of each transect. At each sampling location, a 1.6 ft x 1.6 ft (0.5 m x 0.5 m) quadrat was placed on the ground. The percent cover of each plant species present within each quadrat was visually estimated (viewed from the vertical). A determination was also made as to whether a given plant species was non-native or invasive. To ensure consistency between monitoring events, observations were recorded on standardized data forms.

Cover values for individual species were summed to determine the total areal coverage in each quadrat. Daubenmire method cover classes (0 to 5 percent, 5 to 25 percent, 25 to 50 percent, 50 to 75 percent, 75 to 95 percent, and 95 to 100 percent) and cover class midpoint values (2.5 percent, 15 percent, 37.5 percent, 62.5 percent, 85 percent, and 97.5 percent) for each species also were recorded. See Appendix C for a description of the Daubenmire method.

Plant species analysis was based on the estimated cover and cover class midpoint values. In addition, the percent of each quadrat occurring within herbivory avoidance fencing was recorded to determine whether plant species composition in the protected areas differed from

that outside the fencing. Because the Squally Beach site has natural vegetation that was present prior to restoration planting, data for pre-existing vegetation and planted vegetation along the transects were analyzed separately.

During marsh vegetation sampling, the percent of the quadrat that occurred within the herbivory avoidance fencing was recorded. These data were analyzed to determine whether the fencing influenced species composition in the marsh habitats. This analysis was not conducted during the first monitoring year, but has been included in this monitoring report.

Marsh species composition monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The City of Tacoma monitored the Middle Waterway (City of Tacoma) site.

### 2.7 Biological Success Criterion 3 – Marsh Development/Plant Vigor

---

**MARSH DEVELOPMENT/PLANT VIGOR.** *As measured by stem height and shoot density, should be comparable (greater than 80 percent by Year 3) to that of appropriate reference sites and/or improving over time.* (From Ridolfi and Adolfson, 2001.)

---

Plant vigor was evaluated in mid-summer along the transects and within the quadrats described above for BSC 2. Using the standardized form for BSC 2, the stem height (in inches) and shoot density of sedges (*Carex* and *Scirpus* spp.) were recorded. Data were analyzed for each quadrat in which sedges occurred. In addition, data for sedges in protected areas were compared with data for sedges in unprotected areas to determine whether using herbivory avoidance fencing affected plant vigor.

Marsh development monitoring was conducted at the Mowitch and Squally Beach sites. The naturally vegetated portion of the Squally Beach site provided a comparison for evaluating plant vigor.

### 2.8 Biological Success Criterion 4 – Marsh Development/Herbivory Avoidance

---

**MARSH DEVELOPMENT/HERBIVORY AVOIDANCE.** *Confirm the success of stopping physical herbivory by Canada geese using physical barriers of wire, rope, rebar, posts, string, or netting.* (From Ridolfi and Adolfson, 2001.)

---

Herbivory exclusion devices were inspected and, to evaluate the effectiveness of the devices, plant health was noted. A standardized form was used to create a permanent record of the condition of the devices and the extent to which they were functioning to exclude geese. In addition, each device was photographed whenever a site was sampled to document its success or failure.

Herbivory exclusion monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites concurrently with monitoring for BSCs 1, 2, and 3. At the Mowitch and Squally Beach sites, herbivory avoidance fencing had been reinforced and expanded since the Year 1 (2002) monitoring.

### 2.9 Biological Success Criterion 5 – Riparian Vegetation Survival

---

**RIPARIAN VEGETATION SURVIVAL.** *Riparian vegetation plantings should maintain not less than 75 percent survival over the first three years following initial planting.* (From Ridolfi and Adolfson, 2001.)

---

Riparian vegetation in quadrats along contours through the riparian areas was inspected in mid-summer to evaluate plant survival. Samplers used the "as-planted" surveys as the basis for data collection.

Permanent transects were established generally along contours at each site monitored. The number and location of transects were established prior to the Year 1 (2002) monitoring, and the

locations were permanently marked using rebar. The transects were placed to adequately assess the percent survival and areal coverage of the riparian vegetation, as well as to characterize the plant community. At the Mowitch site, the riparian vegetation transect was extended for Year 2 (2003) monitoring to include vegetation that has been planted in the eastern portion of the site.

Sampling locations along the transect were determined using a random number table. At each sampling location, a 3.3 ft x 9.8 ft (1.0 m x 3.0 m) rectangular quadrat was placed on the ground. The percent survival of each plant species present within each quadrat was visually estimated (viewed from the vertical). To ensure consistency between monitoring events, observations were recorded on standardized data forms.

Riparian vegetation survival monitoring was conducted at the Mowitch and Squally Beach sites.

### 2.10 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

---

**RIPARIAN VEGETATION/AREAL COVERAGE.** *Areal extent of native trees, shrubs, herbs, and other riparian vegetation should be stable or increasing over time, and cover not less than 90 percent of the upland vegetated area of a project after 10 years. Invasive plant coverage should be minimal; species of special concern include* Rubus procerus *(Himalayan blackberry),* Cytisus scoparius *(Scot's broom), and* Polygonum cuspidatum *(Japanese knotweed). By Year 3, minimum percent coverage of vegetation layers should be: >70 percent (herbs); >30 percent (shrubs); > 25 percent (trees); and <2 percent (non-native invasive vegetation).* (From Ridolfi and Adolfson, 2001.)

---

The extent of riparian vegetation was mapped in mid-summer. Stake-wire flags were also placed around areas of dominant (i.e., percent cover 25 percent or greater) riparian vegetation. Dominant plant species were determined based on a visual estimate of area within the polygon and recorded for each mapped polygon by Adolfson staff biologists.

Percent cover in the riparian area was estimated in a 3.3 ft x 9.8 ft (1.0 m x 3.0 m) quadrat located along transects (using the transects and quadrats established for BSC 5). Quadrats were selected on the transects prior to Year 2 monitoring using random numbers from Elzinga et al. (1998). To ensure consistency between monitoring events, observations were recorded on standardized data forms. The coordinates of the center of each quadrat were surveyed by Ridolfi using the total station instrument.

Riparian coverage monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The City of Tacoma monitored the Middle Waterway (City of Tacoma) site.

### 2.11 Biological Success Criterion 7 – Fish Access/Presence

---

**FISH ACCESS/PRESENCE.** *Estuarine fish will access the project, with increasing utilization and colonization by resident species. Juvenile salmonid presence within the project should be comparable to that of appropriate reference sites at the end of 10 years.* (From Ridolfi and Adolfson, 2001.)

---

One of the principal goals of the Commencement Bay restoration program is to provide habitat for juvenile salmon. To monitor progress toward this goal, Ridolfi and NOAA Fisheries personnel teamed to form a four-person crew that used block nets and beach seine nets to sample fish at six sites. The crew collected, identified, and measured the fork length (FL) of salmonids to the nearest millimeter (mm). If possible, hatchery fish were identified by the presence of clipped fins or coded wire tags (CWT). A fraction of the catch was retained by NOAA Fisheries for further analysis of stomach contents and fish chemistry. The remaining fish were released. Stomach content and chemistry results were not available at the time of this report.

Monitoring was conducted at the Mowitch and Middle Waterway (City of Tacoma) sites using block nets and at the Middle Waterway (Simpson/Trustees), Middle Waterway (City of

Tacoma), Yowkwala, Skookum Wulge, and Olympic View sites using beach seine nets. Fish sampling was conducted from April through October on an approximately bimonthly schedule, for a total of 15 sampling events with 128 sets. The Mowitch site was sampled only once in August and was not sampled in September and October because of poor tides. The Trustees have not identified any reference or comparison sites at this point.

### 2.11.1 Block Nets

At the Mowitch site, a 16-ft (5-m) Boston Whaler outboard skiff was used to set four 120 ft x 44 ft (37 m x 13.5 m) block nets made of 0.4 inch (in.) (1 centimeter [cm]) mesh (see Photo 1 in Appendix B). The catch from all four nets was counted as one set for the sampling event. Each block net was attached to a length of rebar driven into the shore on either side of the mouth of each pool to assure full blockage of the outlet. Each block net was equipped with a weighted lead line attached to the bottom of the net, which created a seal along the substrate of the mouth of the pool. A cork line kept the top of the net from sinking below the water surface, thus creating fish blockage. The nets were set during tide cycles that included an 8 ft (2.4 m) or greater high tide and a 0 ft (0 m) or lower low tide. The nets were allowed to "soak" as the tide receded, until the pools were emptied of water; this took approximately three to four hours. Sampling personnel monitored the nets as low tide approached to ensure the catch was not left without water.

As the tide receded, all fish were collected from the nets, identified by genus and species, counted, examined for external anomalies, and released. Additionally, up to 30 specimens from each species of sculpin, flat fish, forage fish, and salmonids were measured before being released. Salmonid fork lengths were measured to the nearest mm (from nose to mid-fork of tail); all other species were measured full length to the nearest mm (from nose to end of tail).

Salmonids were also checked for hatchery marks. These data were used to estimate the proportion of wild to hatchery fish, as well as the hatchery origin of marked fish. Possible hatchery marks include adipose fin clips, right ventral fin clips, left ventral fin clips, and CWTs (Table 3). Sampling personnel examined salmonids for fin clips while the fish were being measured and identified. Tags were detected using a handheld CWT wand detector. Hatchery

fish examined were assumed to originate from the Washington State and tribal hatcheries located in the Puyallup River basin.

**Table 3. Possible marks for Commencement Bay hatchery fish.**

| Species | Source | Mark |
|---|---|---|
| Chinook | White River | Right ventral fin removed |
| Chinook | White River | CWT – no marks |
| Chinook | Puyallup | Adipose fin removed/CWT |
| Chinook | Puyallup | Adipose fin removed |
| Chinook | White River | Pit tag |
| Coho | Puyallup | Adipose fin removed/CWT |
| Coho | Puyallup | CWT – no marks |
| Steelhead | Puyallup | Adipose fin removed |
| Chinook | Puyallup | Left ventral fin removed |

The Puyallup River basin supports wild and hatchery chinook, coho, chum, and pink salmon, as well as steelhead, sea-run cutthroat, bull trout, and Dolly Varden. The Puyallup Tribe, Muckleshoot Tribe, and Washington Department of Fish and Wildlife (WDFW) have hatcheries in the basin that produce spring/fall chinook, coho, and steelhead. Outmigration occurs from March through July, with peak use of the nearshore tidal areas occurring May through June.

For all sampling events, the following data were collected at each site: location, date, time, tide stage (time and height), and weather conditions, including an approximation of air temperature, wind and direction, precipitation, and cloud cover. The time at which each set was deployed was also recorded.

Environmental measurements taken at each block net set included water quality parameters such as temperature and salinity, as well as weather descriptions. A Hydralab Datasonde 4 multiprobe coupled to a Surveyor 4 field display unit and a salinometer supplied by NOAA were used to collect water quality data. Any uncommon events or changes in the sites were noted.

At the Middle Waterway (City of Tacoma) site, one 32 ft x 6 ft (9.7 m x 1.8 m) block net, with an extra wing of approximately 150 ft (50 m) added to cover the distance of the pool to be blocked, was set at high tide using the Boston Whaler skiff. The block net was anchored to the shore and allowed to fish in the same manner as at the Mowitch site. In August, the beach seine net was used at the Middle Waterway (City of Tacoma) site because of poor results with the block net.

### 2.11.2 Beach Seine Nets

At the Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Skookum Wulge, Yowkwala, and Olympic View sites, the Boston Whaler skiff was used to deploy a 120 ft x 8 ft (37 m x 2.4 m) floating "Puget Sound" beach seine net of 0.4 in. (10 mm) mesh (see Figure 2-1). The main part of the beach seine, known as the "wings," is constructed with 1 in. (25 mm) mesh. In between both wings is a "bag" made of ¼ inch (6 mm) mesh and 6 ft (1.8 m) in depth. The bag creates a deep pocket, increasing the chance that fish will be trapped as the net is dragged through the water. Seine nets are equipped with a weighted lead line attached to the bottom of the mesh that creates a seal along the topography of the substrate as the net is being pulled to shore. A cork line attached to the top of the net keeps the net from sinking below the water surface. Attached to each end of the beach seine at the cork line is approximately 50 ft (15 m) of polypropylene line (poly-line), which is used to pull the net to shore.

To conduct the sampling, a sampler stood on the beach and held one end of the net. Two people stayed in the boat to deploy the net. The driver motored backward away from shore approximately 50 ft (15 m), then turned parallel to the shore. The net person began releasing the net as the boat continued to travel backward about 100 ft (30 m) until the net was fully deployed and taut; the driver then turned the boat and motored forward, bringing the full length of the poly-line (boat end of net) to shore (see Photo 2 in Appendix B). The deployer handed off the poly-line to the second sampler. Next, the samplers slowly pulled the full length of the net toward the beach; as the samplers came together on the beach, the net formed a V shape, allowing trapped fish to slide down the wings into the bag (see Photo 3 in Appendix B). Nets were set in the direction the tide was moving at the time.

Captured fish were identified and counted (see Photo 4 in Appendix B) as described for the block net sampling method. Water quality parameters were measured once per sampling event at beach seine sites, roughly in the center of each site, approximately 50 ft (15 m) from shore.

Replicate sets were made at each site if space, time, and tide stage permitted. Care was taken to ensure that the area covered by one set was not duplicated in the replicate sets. This was achieved by moving approximately 10 to 20 ft (3 to 6 m) away from the previous set's endpoint. Time between sets varied between five and 30 minutes, a reflection of the time needed to process fish caught in a set. Beach seining was conducted during high to mid-tide, generally on an outgoing tide.

At the Skookum Wulge site, only one complete set per sampling event was possible because of the site's small area. The Middle Waterway (Simpson/Trustees), Yowkwala, and Olympic View sites were large enough to complete three drifts per sampling event. The Middle Waterway (City of Tacoma) site was large enough to complete two drifts per sampling event. In August, the beach seine net was used at the Middle Waterway (City of Tacoma) site because of earlier poor results with the block net. At times, environmental factors, such as a tide that was too high or too low or mass accumulations of seaweed in the net, prevented the samplers from completing the prescribed number of sets at some sites.

All data were entered into an Excel spreadsheet, then imported into an Access database by Ridolfi personnel. Salmon numbers were adjusted by catch per unit effort (CPUE), and salmon mean average lengths were used in the data analysis. The data were analyzed using Delta Graph 5 software. Fish monitoring field reports for each site and sampling event appear in Appendix D.

### 2.12 Biological Success Criterion 8 – Invertebrate Prey Resource Production

---

**INVERTEBRATE PREY RESOURCE PRODUCTION.** *Production of invertebrate prey taxa known to be important to juvenile salmonids should be comparable to that of appropriate reference or comparison sites at the end of 10 years.* (From Ridolfi and Adolfson, 2001.)

---

This success criterion was monitored by NOAA scientist Alex von Saunders at the Mowitch, Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Yowkwala, and Skookum Wulge sites. Her findings will be the subject of a separate report.

### 2.13 Biological Success Criterion 9 – Bird Use

---

**BIRD USE.** *Use of project sites including an area beyond 50 meters of the site boundaries by indigenous/native bird species should be comparable to reference/comparison sites.* (From Ridolfi and Adolfson, 2001.)

---

Prior to the first visit, the monitoring team identified a means for approaching each site to minimize disturbance, and observations were therefore made from relatively inconspicuous locations. In subsequent events, monitors will approach from the same directions. This technique is intended to reduce observer influences on monitoring results and to increase the reproducibility of bird counts.

Between May and November, bird use was observed and recorded during early mornings for periods of half an hour to an hour. Using a standardized form, observers recorded bird species on site and within approximately 150 ft (50 m) of the site boundary, as well as the type of observation (i.e., seen, heard, tracks, flyover) and climatic and tidal factors that could influence bird use of the site.

Bird monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The Trustees have not identified any reference or comparison sites at this point.

# 3.0 MONITORING RESULTS

This section describes monitoring results by site in the same order the PSCs and BSCs are outlined in Section 2. Maps presented in this section were created using AutoCAD software and cross sections were prepared in Delta Graph. Biological observations were recorded on data forms in the field and then entered into an Access database developed for the project. Ridolfi personnel performed the data entry; entries were spot-checked for quality control. The database was queried to generate the site-specific summary tables presented in this section. Fish monitoring data, which were collected and summarized by Ridolfi and NOAA Fisheries personnel, were subsequently imported into the database for archival purposes.

## 3.1 Mowitch

Information collected at the Mowitch site included physical, vegetation (marsh and riparian), fish, invertebrate, and avian data. Ridolfi performed the topographic surveying and fish monitoring; NOAA Fisheries personnel participated in the fish monitoring; Adolfson performed the vegetation and avian monitoring; and NOAA personnel collected invertebrate data, which will be the subject of a separate report. The Mowitch site data are discussed below in terms of the physical and biological success criteria applicable to the site for Year 2 monitoring.

### 3.1.1 Physical Success Criterion 2 – Intertidal Stability

Intertidal stability at the Mowitch site was evaluated by surveying the +8, +10, and +13.5 ft (+2.4, +3.0, and +4.1 m) MLLW contours. These contours are shown on Figure 3-1 along with similar contours from the 2000 as-built survey and the Year 1 (2002) survey. Differences between the 2000, 2002, and 2003 contours reflect a combination of topographic changes at the Mowitch site and differences in surveying technique. The primary difference in technique is that the as-built contours were interpolated from spot elevations, while the surveying was done along contours in 2002 and 2003.

*Success Criterion Evaluation*. Based on visual and areal comparison between the three sets of contours, there do not seem to be any significant changes and intertidal stability appears good. Overall, PSC 2 is being met at the Mowitch site.

### 3.1.2 Physical Success Criterion 3 – Tidal Circulation

Tidewater was free to flow through each of the three openings between the tidal pools and Hylebos Creek and between the northernmost tidal pool and the Hylebos Waterway. A number of logs had floated onto flat areas (benches) between the tidal pools at an elevation near MHW, although this was less noticeable than in 2002. On occasion (prior to the formal monitoring described in this report), significant quantities of bark debris have also been observed at the site (Adams, 2002). Both types of events, which are likely to be associated with commercial log handling activities in the Hylebos Waterway, can have negative impacts on the growth of marsh vegetation, even though tidal circulation itself is not restricted.

*Success Criterion Evaluation*. No tidal circulation problems or blockage problems were observed at the Mowitch site, indicating that PSC 3 is being met.

### 3.1.3 Physical Success Criterion 4 – Elevation and Channel Morphology

Elevation and channel morphology at the Mowitch site was evaluated by surveying ten cross sections approximately perpendicular to the site's long axis. The cross sections are shown on Figures 3-2a through 3-2e. Each cross section also shows the data collected in the 2000 as-built survey and the Year 1 (2002) survey. It should be noted, however, that the as-built survey was not performed using the same cross-section alignments as in the Year 1 and Year 2 monitoring, i.e., the points on each cross section were interpolated from a contour map of the as-built survey. Consequently, differences shown on the cross sections reflect both real differences associated with topographic changes between the surveys and artificial differences associated with the interpolation process.

*Success Criterion Evaluation*. Generally, the 2003 elevations agree with the 2000 and 2002 elevations within 6 in. (150 mm) or less, and the changes between 2002 and 2003 were minimal. PSC 4 is being met at the Mowitch site.

### 3.1.4 Biological Success Criterion 1 – Marsh Development/Areal Coverage

*Introduction*. The areal extent of marsh vegetation at the Mowitch site is shown on Figure 3-3. The percent cover of vegetation and the dominant species present in each polygon are shown in Data Table 3-1, Appendix A. Sixty-nine quadrats were sampled along two marsh transects, designated Transects 1-1 and 1-2, running through marsh areas at or near elevation +12 ft (+3.7 m) MLLW (Figure 3-3). The location of each quadrat along each transect is shown in Data Table 3-2, Appendix A. The percent cover of vegetation in each quadrat by species is shown in Data Tables 3-3a and 3-3b, Appendix A.

*Marsh Vegetation Mapping*. Dominant marsh species on the Mowitch site included Douglas aster (*Aster subspicatus*), spike-rush (*Eleocharis* sp.), fat-hen saltbush (*Atriplex patula*), and brass buttons (*Cotula coronopifolia*), with the spike-rush being most prevalent (Data Table 3-1, Appendix A). Other species that frequently occurred on the site included seashore saltgrass (*Distichlis spicata*), seaside arrowgrass (*Triglochin maritimum*), and saltmarsh sandspurry (*Spergularia marina*). In general, areal coverage and plant species diversity was greatest within the areas protected with herbivory avoidance fencing. Vegetation outside of the fencing on the three lobes consisted primarily of small monotypic patches of spike-rush, although brass buttons has also become established and was co-dominant in places. Near the northern end of the site, marsh vegetation, such as Douglas aster and fat-hen saltbush, has become established outside of the fencing.

During Year 1 (2002) monitoring, many small patches of vegetation were interspersed on the site. Since then, marsh vegetation cover has increased, and there is now a nearly continuous patch of marsh vegetation immediately downslope from the riparian habitat. This includes the marsh area from the south end of the site to approximately 750 ft (230 m) north (Figure 3-3). Three small patches of Douglas aster and fat-hen saltbush that were not identified in 2002 as vegetated patches exceeding 20 percent cover extend north of this area. Some of the increased areal coverage may be attributed to the time of year in which the 2003 monitoring was conducted (late summer, as compared to early summer in 2002). However, it appears that new patches of marsh vegetation have become established since the first year of monitoring and that many of the patches identified last year have increased in areal extent.

*Daubenmire Method Analysis*. The total canopy cover as calculated using the Daubenmire method, which is described in Appendix C, is presented in Data Tables 3-4a and 3-4b, Appendix A. The total canopy cover along Transect 1-1 increased from 510 in 2002 to 1,625 in 2003. The canopy cover percentage also increased along this transect, from 11.1 percent in 2002 to 35.3 percent in 2003. Transect 1-2 was not sampled in 2002, so no data are available for comparison.

*Success Criterion Evaluation*. BSC 1 has been met, as the areal cover of marsh appears to be increasing on the site.

### 3.1.5 Biological Success Criterion 2 – Marsh Development/Species Composition

*Introduction*. The two marsh transects were sampled during the Year 2 (2003) monitoring. The locations of the two marsh transects are shown on Figure 3-3. Plant species identified in each quadrat along these marsh transects are presented in Data Tables 3-3a and 3-3b, Appendix A. Information from these tables was used to determine the species composition along both marsh transects. The tables also indicate whether plants are native or non-native.

#### Transect 1-1

*Descriptive Analysis*. Of the 46 marsh quadrats sampled along Transect 1-1, 36 contained vegetation. The species that occurred most frequently were brass buttons, seaside arrow-grass, and fat-hen saltbush. Of the 13 species observed along the transect, nine are native and four are non-native.

Percent cover in the quadrats ranged from 0 percent (unvegetated) to 100 percent. Variation could be attributed to substrate, micro-site conditions, and the time of year in which the survey was conducted. Eight species having relatively high percent cover (greater than 20 percent) within individual quadrats are listed below.

- Seashore saltgrass;
- Saltmarsh sandspurry;
- Brass buttons;
- Fat-hen saltbush;

- Lyngby's sedge (*Carex lyngbyei*);
- Seaside arrow-grass;
- Seaside plantain (*Plantago maritima*); and
- Spike-rush.

The average percent cover for all 13 species identified along the transect is presented in Data Table 3-3a, Appendix A. The two species with the highest average percent cover are seashore saltgrass (7.5 percent), a native species, and brass buttons (5.4 percent), a non-native species. Saltmarsh sandspurry, a non-native plant species, and seaside arrowgrass, a native species, had fairly high average percent cover at 4.9 and 4.7 percent, respectively.

Of the 46 quadrats along this transect, 16 were entirely within herbivory avoidance fencing, three were partially within the fencing, and 27 were entirely outside of the fencing. Data Table 3-3a (Appendix A) shows that the quadrats falling within the fenced areas had the greatest plant species diversity and greatest overall percent cover. Of the 27 quadrats that were entirely outside of the fencing, 12 had either no vegetation or less than 1 percent cover of marsh vegetation.

Data taken along Transect 1-1 during Year 2 (2003) were compared to data taken along the same transect during Year 1 (2002). In 2002, 26 of 46 quadrats contained vegetation, while in 2003, ten more (36 of 46) quadrats contained vegetation. However, the number of species observed along the transect decreased from 16 in 2002 to 13 in 2003. Fat-hen saltbush and brass buttons occurred most frequently within individual quadrats during both years; however, seaside arrow-grass was also frequent in 2003. Maximum percent cover within the quadrats increased from 95 percent in 2002 to 100 percent in 2003. Six quadrats had 100 percent cover in 2003, while no quadrats had 100 percent cover in 2002.

*Daubenmire Method Analysis*. Plant cover was also analyzed using the Daubenmire cover class and midpoint method, as described in Appendix C. Data presented in Data Table 3-4a, Appendix A, show that seashore saltgrass, a native plant species, had the greatest canopy cover (320) and percent canopy cover (7.0 percent); however, fat-hen saltbush and seaside arrow-grass occurred more frequently, with a frequency of 32.6 percent each. Both seaside arrow-grass and

seaside plantain have good cover on the site, with a total canopy cover of 185 and 172, respectively, and a percent canopy cover of 4.0 and 3.8 percent. However the frequency at which seaside arrow-grass occurred (32.6 percent) was higher than that of seaside plantain (23.9 percent).

Based on the results of the Daubenmire method, fat-hen saltbush had the greatest canopy cover (180.0) and percent cover (3.9 percent) within this site in 2002, while in 2003 seashore saltgrass had the greatest canopy cover (320.0) and percent canopy cover (7.0 percent). In addition, fat-hen saltbush was more frequent in 2002, while both fat-hen saltbush and seaside arrow-grass were frequent in 2003.

*Success Criterion Evaluation*. Both Transects 1-1 and 1-2 (discussed below) exceed 5 percent cover of non-native or invasive plant species. Additional weed control is needed at this site to reduce the percent cover below the 5 percent threshold.

**Transect 1-2**

*Descriptive Analysis*. Data were collected for an additional transect, Transect 1-2, as part of the Year 2 (2003) monitoring. This information will be used for future comparisons of vegetation occurring along this transect. Of the 23 marsh quadrats sampled along Transect 1-2, 17 contained vegetation. The species that occurred most frequently along the marsh transect were brass buttons and spike-rush. Of the ten species observed along the transect, seven are native and three are non-native.

Percent cover in the quadrats ranged from 0 percent (unvegetated) to 60 percent. Variation could be attributed to substrate, micro-site conditions, and the time of year in which the survey was conducted. Four species that had relatively high percent cover (greater than 20 percent) within individual quadrats are:

- Spike-rush;
- Brass buttons;
- Saltmarsh sandspurry; and
- Fat-hen saltbush.

The average percent cover for all species identified along the transect is presented in Data Table 3-3b, Appendix A. Spike-rush, which is a relatively small plant, had the greatest average percent cover (11.3 percent). Two non-native plant species, saltmarsh sandspurry (6.1 percent) and brass buttons (5.1 percent), have relatively high average percent cover. The species composition along this transect is likely influenced by having fewer planted species in the northwestern portion of the lobes and a greater likelihood of surface scouring by logs from the adjacent lot.

Of the 23 quadrats along this transect, seven were entirely within herbivory avoidance fencing, one was mostly within the fencing, and 15 were entirely outside of the fencing (Data Table 3-3b, Appendix A). Spike-rush, brass buttons, and saltmarsh sandspurry occurred frequently, had relatively high cover, and were present both inside and outside of the fencing. Along this transect, fencing does not appear to have increased the diversity of native plants species or the frequency with which they occur.

*Daubenmire Method Analysis*. Plant cover was also analyzed using the Daubenmire cover class and midpoint method, as described in Appendix C. Data in Data Table 3-4b, Appendix A, show that spike-rush had the greatest canopy cover (232.5), percent canopy cover (10.1 percent), and frequency (47.8 percent) in the marsh area. Seaside arrow-grass and fat-hen saltbush, both commonly occurring species, each have a total canopy cover of 20, percent canopy cover of 0.9, and frequency of 13.0 percent. All three species are native.

*Success Criterion Evaluation*. Both Transects 1-1 and 1-2 exceed 5 percent cover of non-native or invasive plant species. Additional weed control is needed at this site to reduce the percent cover below the 5 percent threshold.

### 3.1.6 Biological Success Criterion 3 – Marsh Development/Plant Vigor

*Introduction*. Stem height and shoot density, which were used to assess plant vigor, are shown in Data Tables 3-5 and 3-6, Appendix A, respectively. During Year 1 (2002) monitoring, stem height and shoot density data were collected for all marsh vegetation within the marsh quadrats. Only sedges (*Scirpus* and *Carex* spp.) were sampled during Year 2 (2003) monitoring.

*Descriptive Analysis.* Only one sedge species (Lyngby's sedge) was observed along marsh Transect 1-1. This species occurred only within the herbivory avoidance fencing. Based on this year's data, stem height varied between 4 and 23 in. for Lyngby's sedge, with an average stem height of 11.6 in. Shoot density varied between one and 38 shoots per quadrat, with an average shoot density of 15.7.

Data taken along Transect 1-1 during Year 2 (2003) were compared to data taken along the same transect during Year 1 (2002). Average stem height and average stem density of Lyngby's sedge have increased from 9.0 in. and 6.5 shoots per quadrat, respectively, in 2002, to 11.6 in. and 15.7 shoots per quadrat in 2003. Stem height has increased by 29 percent, and stem density has more than doubled.

*Success Criterion Evaluation*. Results for Year 2 monitoring show that vigor has increased for Lyngby's sedge between 2002 and 2003. If the sedge continues to increase through next year, it may meet the success criterion of 80 percent of appropriate reference site by the end of Year 3 (2004).

### 3.1.7 Biological Success Criterion 4 – Marsh Development/Herbivory Avoidance

Herbivory avoidance fencing has been installed in four places within marsh polygon MA and around marsh polygon MM (Figure 3-4). Most of the fencing is made from rebar, chicken wire, rope, and strings. Chainlink fencing was added to the western half of the structure on the middle lobe in 2003.

Herbivory avoidance fencing on the site was intact except for the southernmost portion in marsh polygon MA, which had some broken strings along the top. However, all of the structures appeared to be working, because there was little to no evidence of grazing or of geese having accessed the fenced areas.

*Success Criterion Evaluation*. This site has met the requirements for BSC 4.

### 3.1.8 Biological Success Criterion 5 – Riparian Vegetation Survival

*Introduction*. The location of the riparian vegetation transect is shown on Figure 3-3. The location of each quadrat along the transect is shown in Data Table 3-2, Appendix A. The percent cover of each of the plant species identified in the 46 quadrats along the riparian transect is presented in Data Table 3-7, Appendix A.

*Descriptive Analysis*. Based on survival information derived from the analysis of quadrat data, the majority of planted species are surviving. Of the 46 quadrats that contained native shrub and/or tree species, however, 19 contained native shrubs and/or trees that were not surviving. Tree species noted as not surviving within the quadrats included seven Douglas fir (*Pseudotsuga menziesii*), five western red cedar (*Thuja plicata*), and two Oregon ash (*Fraxinus latifolia*). Larger conifer trees, which were planted in fall of 2002, are among those that did not survive. Shrub species noted as not surviving within the quadrats included one vine maple (*Acer circinatum*), one oceanspray (*Holodiscus discolor*), one Pacific ninebark (*Physocarpus capitatus*), and one rose (*Rosa* sp.).

Douglas fir and western red cedar had the lowest survival rates within the quadrats, with only one of eight quadrats containing a surviving Douglas fir and only one of six quadrats containing a surviving western red cedar. Survival problems may have been caused by compacted soils, inadequate watering during the summer, or plant stress (i.e., larger trees may have been shocked by replanting).

Species that did well within the quadrats included beaked hazelnut (*Corylus cornuta*), common snowberry (*Symphoricarpos albus*), red-osier dogwood (*Cornus stolonifera*), and red alder (*Alnus rubra*), which were surviving in 100 percent of the quadrats in which they were found. Other species with high survival rates included rose (surviving in 96 percent of the quadrats in which it was found) and Oregon ash (surviving in 75 percent of the quadrats in which it was found).

The Year 2 (2003) monitoring results show an increase in mortality from Year 1 (2002). In 2002, 13 trees and shrubs were observed to be dead within the quadrats; during this year's monitoring, 19 trees and shrubs were observed to be dead within the quadrats. Conifer species

had the highest mortality rates during both monitoring years. Of the 119 shrub and tree species observed within the quadrats, 99 species were surviving, for a percent survival of 83 percent.

Scot's broom (*Cytisus scoparius*) and Himalayan blackberry (*Rubus discolor*), which are non-native and invasive species, were found on the Mowitch site during Year 1 and Year 2 monitoring. Scot's broom was found in four quadrats during both the 2002 and 2003 monitoring years. Himalayan blackberry was found in one quadrat during 2002 and in 14 quadrats during the 2003 monitoring year.

*Daubenmire Method Analysis*. Data were also analyzed using the Daubenmire cover class and midpoint method. Data in Data Table 3-8, Appendix A, indicate that the herbaceous layer makes up the majority of total canopy cover, the greatest percent canopy cover, and the majority of the species composition. In the herbaceous layer, birds-foot trefoil (*Lotus corniculatus*) provided the highest total canopy cover (677.5) and percent canopy cover (14.7 percent). Within the shrub layer, rose had the greatest total canopy cover (302.5) and percent canopy cover (6.6 percent), while red alder had the highest total canopy cover (247.5) and percent canopy cover (5.4 percent) in the tree layer.

In 2002, perennial ryegrass (*Lolium perenne*) provided the highest total canopy cover (555) and percent canopy cover (12.3 percent) in the herbaceous layer. Within the shrub layer, rose had the greatest total canopy cover (215) and percent canopy cover (4.8 percent), while Douglas fir had the highest total canopy cover (92.5) and percent canopy cover (2.1 percent) in the tree layer.

*Success Criterion Evaluation.* Vegetation on the site is currently meeting the 75 percent survival success criterion. Invasive species such as Scot's broom and Himalayan blackberry are beginning to establish within the mitigation area.

### 3.1.9 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

*Introduction*. The areal extent of riparian vegetation is shown on Figure 3-3. The percent cover of vegetation and the dominant species present in each polygon are presented in Data Table 3-1, Appendix A. Forty-six quadrats were sampled along a transect through on-site riparian habitat

at or near elevation +14 ft (+4.3 m) MLLW (Figure 3-3). The location of each quadrat along each transect is shown in Data Table 3-2, Appendix A. The percent cover of vegetation in each quadrat by species is shown in Data Table 3-7, Appendix A.

*Riparian Vegetation Mapping*. The areal extent of riparian vegetation on the Mowitch site is shown on Figure 3-3. The dominant riparian vegetation included red alder, red-osier dogwood, rose, and sickle-keeled lupine (*Lupinus albicaulis*). A number of early seral herbaceous plant species, such as black medick (*Medicago lupilina*), yarrow (*Achillea millefolium*), white sweet-clover (*Melilotus alba*), willow-herb (*Epilobium* spp.), and plantain (*Plantago* spp.), are also present in the understory.

The areal extent of vegetation in 2003 was approximately the same as in 2002. However, the areal cover of native trees and shrubs has increased over the past year.

*Descriptive Analysis*. Vegetative cover varied from 1 percent to 65 percent within each quadrat (Data Table 3-7, Appendix A). Data Table 3-7 also shows that 15 plant species had relatively high coverage (greater than 20 percent) within individual quadrats. Of these, ten were herbaceous, three were trees, and two were shrubs. The native plant species having relatively high coverage (greater than 20 percent) included:

- Sickle-keeled lupine;
- Yarrow;
- Red-osier dogwood; and
- Rose.

Douglas fir and western red cedar also had relatively high percent cover; however, survival of trees was not high. Therefore, the upper percent cover for both the Douglas fir and the western red cedar represents a quadrat in which both of these plants were found surviving. The overall areal cover of both these trees would have been higher had more of the trees survived.

Planting trees and shrubs in November 2002 increased the cover of woody plant species on the site. In addition, the vegetation on the site is now more heterogeneous, with fewer areas dominated by herbaceous vegetation. In Year 1 (2002), the mapped riparian habitats were

primarily dominated by herbaceous vegetation, although some trees and shrubs were present on the site. In Year 2 (2003), the cover of native trees and shrubs in the riparian habitat has increased. However, many of the early seral herbaceous species that were present during the Year 1 monitoring were still present in Year 2.

*Daubenmire Method Analysis*. Data were also analyzed using the Daubenmire cover class and midpoint method, described in Appendix C. Data in Data Table 3-8, Appendix A, show that herbaceous vegetation, much of which is non-native or invasive, composes much of the vegetative cover in the riparian area. The herbaceous species with the greatest total canopy cover are birds-foot trefoil (677.5), sickle-keeled lupine (285), yarrow (220), redtop (*Agrostis alba*) (210), willow-herb (195), and white sweet-clover (180). Rose had the highest total canopy cover (302.5), percent canopy cover (6.6 percent), and frequency (24 percent) in the shrub layer. Red alder had the highest total canopy cover (247.5), percent canopy cover (5.4 percent), and frequency (20 percent) in the tree layer, although Douglas fir and western red cedar had a total canopy cover of 105 and 100, respectively, and a percent canopy cover of 2.3 percent and 2.2 percent.

The total canopy cover and percent canopy cover for herbaceous vegetation increased from 1,900 and 42.2 percent, respectively, in 2002 to 3,065 and 66.6 percent in 2003. Within the shrub layer, the total canopy cover and percent canopy cover were reduced from 552.5 and 12.3 percent, respectively, in 2002 to 457.5 and 10.0 percent in 2003. Within the tree layer, the total canopy cover and percent canopy cover increased from 192.5 and 4.3 percent, respectively, in 2002 to 557.5 and 12.1 percent in 2003.

*Success Criterion Evaluation*. The areal extent of native trees and shrubs has increased from the previous year. However, additional plantings will likely be needed to achieve the minimum percent cover of trees (>25 percent) and shrubs (>30 percent) by Year 3 (2004). In addition, greater control of non-native and invasive plant species is needed to reduce these species to less than 2 percent by Year 3.

### 3.1.10 Biological Success Criterion 7 – Fish Access/Presence

*Introduction*. The Mowitch site was sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Data Table 3-9 (Appendix A). Fish sampling occurred once in April and biweekly May through July. Because of conflicting tides, only one sampling event occurred in August, the final event for the season.

The customized fishing gear built for the project functioned as intended. Over the five-month sampling period, 36 individual block net sets were completed at the Mowitch site during nine sampling events for a total of nine sets. The block net design is described in Section 2.11.1.

*Descriptive Analysis*. Complete catch records were kept for all sampling events, and lengths were recorded for selected species as described in Section 2.11. The number of species (species richness, or SR) per sampling event ranged from six to 13. In total, 23 different species (total SR) were caught at the site during various sampling events. The greatest number of species was caught in June (Figure 3-5a). The Mowitch site had the second-highest SR of any of the sites (Figure 3-6a). Five salmonid species, including cutthroat trout, were present during the sampling season. Shiner perch and Pacific staghorn sculpin were the most abundant species observed over the sampling period, with shiner perch being the dominant species. Forage fish such as herring were also observed. Complete catch results for the Mowitch site are listed in Data Table 3-10 (Appendix A).

The peak catch for salmon occurred in late April. Salmon were not seen at the Mowitch site after mid-June. The peak catch for chinook was observed in late April (Figure 3-7a). The most abundant salmonid species observed at the Mowitch site was chum (Data Table 3-10, Appendix A). Two cutthroat trout were sampled in April and May. Table 4 summarizes the total catch and average per set (i.e., CPUE) for juvenile salmon caught at the Mowitch site.

**Table 4. Summary of total juvenile salmon caught and average numbers of salmon per net observed at the Mowitch site for Year 2 (2003) monitoring.**

| Species | Number of Salmon Caught | Average per Set/Catch per Unit Effort |
|---|---|---|
| Chinook | 9 | 1 |
| Coho | 1 | 0.11 |
| Chum | 48 | 5.33 |
| Pink | 1 | 0.11 |
| Total salmon | 59 | 6.55 |

A fraction of the catch was retained by NOAA Fisheries for analysis of stomach contents and fish chemistry. The results of the analyses were not available at the time of this report.

*Success Criterion Evaluation*. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Mowitch site.

### 3.1.11 Biological Success Criterion 9 – Bird Use

*Introduction*. The number of species observed at the Mowitch site between April and November ranged from seven to 20, with the greatest number of species observed during May (20 and 19 species) and April (17 species). The fewest number of species was observed in November. The total number of species recorded increased slightly over Year 1 monitoring, from 31 in 2002 to 32 in 2003. The average number of species observed per visit remained steady: 13.7 in 2003, 13.8 in 2002. Seasonal bird counts recorded at the Mowitch site for Year 2 monitoring are presented in Data Table 3-11, Appendix A.

*Descriptive Analysis*. The number of species observed in the riparian habitat was greatest in April and May (four to seven species present). Only one species was observed in the riparian habitat on June 13, 2003, and two species were observed during two visits in September and the November visit. Because noise in the surrounding environment interfered with the ability to hear auditory indications of bird presence, staff had to rely on visual observations. Because birds can go unseen, yet their presence can be confirmed by sound, it is likely that more species are present in the riparian habitat than were recorded in this study; however, noise conditions

are likely to be relatively similar from one year to the next, providing consistent monitoring conditions.

Use of the marsh and intertidal habitat was greatest from March to June, with seven to nine species present per site visit. The fewest number of species (two) was observed in late September. Use of the site's open-water habitat was variable, with one to four species typically present. Bird use observed at the Mowitch site during Year 2 monitoring is detailed in Data Table 3-12, Appendix A.

The single species present during all field visits was house finch (*Carpodacus mexicanus*); mallard (*Anas platyrhynchos*) and kingfisher (*Ceryle* sp.) were present during nine of ten field visits. Canada goose (*Branta canadensis*) was observed during seven of ten site visits, with a high of 38 individuals observed on June 18, 2003. Numbers of European starling (*Sturnus vulgaris*) were lower in Year 2 than in Year 1, with a high of 60 observed on September 30, 2003, as compared to 40 to 100 European starling observed during visits in August, September, and November 2002.

Waterfowl species observed at the Mowitch site in 2003 included American wigeon (*Anas americana*), Canada goose, double-crested cormorant (*Phalacrocorax auritus*), mallard, northern shoveler (*Anas clypeata*), and pied-billed grebe (*Podilymbus podiceps*). Shorebird species included semipalmated sandpiper (*Calidris pusilla*), killdeer (*Charadrius vociferous*), spotted sandpiper (Actitis macularia), and one individual of an unidentified *Caladris* species. Spotted sandpiper were observed during seven of ten field visits. Great blue heron (*Acdea herodias*) were observed on four occasions.

Two raptor species were observed at the Mowitch site: a red-tailed hawk (*Buteo jamaicensis*) on May 15, 2003, and an osprey (*Pandion haliaetus*) on May 29, 2003.

In 2003, bird species that were observed displaying obvious breeding/territorial behavior, such as singing, fighting, or pursuit, "broken-wing" distraction technique, the gathering of nesting material, and the presence of young, included:

- American robin (*Turdus migratorius*);

- Song sparrow (*Melospiza melodia*);
- White-crowned sparrow (*Zonotrichia leucophrys*);
- Canada goose;
- Cliff swallow (*Petrochelidon pyrrhonota*);
- Killdeer;
- Mourning dove (*Zenaida macroura*);
- Brewer's blackbird (*Euphagus cyanocephalus*);
- House finch;
- Spotted sandpiper; and
- Mallard.

In 2003, 11 species were observed displaying breeding or territorial behavior, compared to eight in 2002. As noted in the Year 1 (2002) report (Ridolfi and Adolfson, 2003), swallows are not nesting on the site, but collect nesting material there. See Data Table 3-12, Appendix A, for details on bird use at the Mowitch site.

Species observed on the site only in the spring included cliff swallow and semipalmated sandpiper. Species observed only in the autumn included northern shoveler and pied-billed grebe. Species counts were greater in spring 2003 (27) as compared to 2002 (15) and were lower in summer and autumn 2003 (18 each) as compared to 2002 (22 and 21, respectively).

As was the case in 2002, tide level did not appear to influence the number of species observed using the site.

*Success Criterion Evaluation*. Based on the presence of numerous birds in a variety of species, BSC 9 is being met at the site. However, there is no reference site against which to make a definitive comparison.

### 3.2 Squally Beach

Information collected at the Squally Beach site included physical, vegetation (marsh and riparian), and avian data. Ridolfi performed topographic surveying, and the vegetation and

avian data were collected by Adolfson. The Squally Beach site data are discussed below in terms of the physical and biological success criteria applicable to the site for Year 2 monitoring.

### 3.2.1 Physical Success Criterion 2 – Intertidal Stability

Intertidal stability at Squally Beach was evaluated by surveying the +10 and +13.5 ft (+3.0 and +4.1 m) contours. These contours are shown on Figure 3-8 along with similar contours from the 2000 as-built survey and the Year 1 (2002) survey. Differences between the 2000, 2002, and 2003 contours reflect a combination of topographic changes at the Squally Beach site and differences in surveying technique. The primary difference in technique is that the as-built contours were interpolated from spot elevations, while the surveying was done along contours in 2002 and 2003.

*Success Criterion Evaluation*. Based on visual and areal comparisons between the three sets of contours, there do not seem to be any significant changes and intertidal stability appears good. A possible exception is the eastern channel directly south of the rockbox outlet (near cross-section B-B', Figure 3-9a). A channel approximately 1 ft deep has eroded at that location. Except in that limited area, PSC 2 is being met at the Squally Beach site.

### 3.2.2 Physical Success Criterion 4 – Elevation and Channel Morphology

Elevation and channel morphology at the Squally Beach site was evaluated by surveying six cross sections approximately perpendicular to the long axis of the site. The cross sections are shown on Figures 3-9a through 3-9c. Each cross section also shows the data collected in the 2000 as-built survey and the Year 1 (2002) survey. It should be noted, however, that the 2000 as-built survey was not performed using the same cross-section alignments as in 2002 and 2003, i.e., the points on each cross section were interpolated from a contour map of the as-built survey. Consequently, differences shown on the cross sections reflect both real differences associated with topographic changes between the surveys and artificial differences associated with the interpolation process.

*Success Criterion Evaluation*. The cross sections show little change between the 2002 and 2003 surveys. However, as in 2002, surface runoff from Marine View Drive flowing around the east

end of the riparian berm has caused some localized rill erosion. With this exception, PSC 4 is being met at the Squally Beach site.

### 3.2.3 Biological Success Criterion 1 – Marsh Development/Areal Coverage

*Introduction*. The areal extent of marsh vegetation at the Squally Beach site is shown on Figure 3-10. The percent cover of vegetation and the dominant species present in each polygon are shown in Data Table 3-13, Appendix A. Thirty-seven quadrats were sampled in planted areas along two transects, Transect 1-1 and 1-2, running through marsh areas at or near elevation +11 ft (+3.4 m) MLLW. In addition, 16 quadrats were sampled along Transect 1-3 in the lower marsh area at approximately +9 to +12 ft (+2.7 to +3.7 m) MLLW. The location of each quadrat along each transect is shown in Data Table 3-14, Appendix A. The percent cover of vegetation in each quadrat by species is shown in Data Tables 3-15a through 3-15d, Appendix A.

*Marsh Vegetation Mapping*. The topographically low areas along transects generally were less vegetated than adjacent marsh areas at slightly higher elevations. As noted last year, this may be due to tidal action: The low areas are inundated on a daily basis and have the greatest potential for surface scouring as water flows in and out of the site. Dominant vegetation included fat-hen saltbush, seashore saltgrass, and pickleweed (*Salicornia virginica*), with fat-hen saltbush being the most prevalent species.

With the addition of herbivory avoidance fencing around most of the marsh habitat, the areal extent of vegetation is increasing on the Squally Beach site. Much of the increase since last year has occurred in the lower marsh areas.

*Daubenmire Method Analysis*. The total canopy cover along Transects 1-1 and 1-2, as calculated using the Daubenmire method (Appendix C), increased from 717.5 and 662.5, respectively, in 2002 to 777.5 and 1,232.5 in 2003. The percent canopy cover also increased along these transects, from 27.6 and 44.2 percent, respectively, in 2002 to 35.3 and 82.2 percent in 2003. Transect 1-3 was established on the site during Year 2 monitoring; therefore, there is no data from 2002 for comparison.

*Success Criterion Evaluation*. BSC 1 is being met at the Squally Beach site in areas where marsh vegetation was planted.

### 3.2.4 Biological Success Criterion 2 – Marsh Development/Species Composition

*Introduction*. Three marsh transects, Transect 1-1, Transect 1-2, and Transect 1-3, were sampled during the Year 2 (2003) monitoring of the Squally Beach site. The locations of the three marsh transects are shown on Figure 3-10. The locations of each quadrat along the transects are shown in Data Table 3-14, Appendix A. Plant species identified in the quadrats along each transect are presented in Data Tables 3-15a through 3-15d, Appendix A. Information from these tables was used to determine the species composition along the marsh transects. The tables also indicate whether plants are native or non-native.

#### Transect 1-1

*Descriptive Analysis*. Of the 22 marsh quadrats sampled in the planted areas along Transect 1-1, 15 contained vegetation (Data Table 3-15a, Appendix A). The species that occurred most frequently along the marsh transect were fleshy jaumea (*Jaumea carnosa*) and fat-hen saltbush. Of the seven species observed along the transects, six are native and one is non-native.

Percent cover for each of the species occurring in the quadrats ranged from 0 percent (unvegetated) to 70 percent. Variation may be attributed to substrate, elevation and tides (duration of inundation and surface scouring), and the patchiness of some species. Five species having relatively high percent cover (greater than 20 percent) within individual quadrats are:

- Fleshy jaumea;
- Fat-hen saltbush;
- Sea milkwort (*Glaux maritima*);
- Seashore saltgrass; and
- Pickleweed.

The average percent cover for all seven species observed along Transect 1-1 is presented in Data Table 3-15a, Appendix A. Fleshy jaumea, a native species, had the highest average percent

cover (11.0 percent), while fat-hen saltbush, also a native species, was relatively high (8.9 percent). Brass buttons, a non-native species, had the lowest average percent cover (0.1 percent).

Of the 22 quadrats along this transect, 13 were entirely within the herbivory avoidance fencing, seven were partially within the fencing, and two were completely outside the fencing. Of the 13 quadrats that were entirely within the fencing, five were unvegetated. The five unvegetated quadrats occurred in substrates inappropriate for vegetation establishment, either in very gravelly areas or in muddy areas exposed to surface scouring as tides move in and out of the marsh habitat. The eight vegetated quadrats within the herbivory avoidance fencing did not necessarily show increased plant species diversity, but appeared to show increased overall percent cover of species.

A comparison of data taken along Transect 1-1 in Year 2 to data from Year 1 showed a decrease in the number of quadrats containing vegetation. In 2002, 20 of 26 quadrats contained vegetation, while in 2003, 18 of 26 quadrats contained vegetation, including both planted and pre-existing vegetation. The number of species observed along the transect decreased from 22 in 2002 to seven in 2003. Fleshy jaumea and fat-hen saltbush occurred most frequently within individual quadrats during both years.

*Daubenmire Method Analysis*. Plant cover was also analyzed using the Daubenmire cover class and midpoint method, as described in Appendix C. Data presented in Data Table 3-16a, Appendix A, show that along Transect 1-1, fleshy jaumea, a native plant species, had the greatest total canopy cover (250), the greatest percent canopy cover (11.4 percent), and a frequency of 10 percent; fat-hen saltbush occurred slightly more frequently (11 percent). Data Table 3-16a also shows that along Transect 1-1, total canopy cover of native plant species (775) is considerably higher than for the non-native or invasive species (2.5).

Based on results of the Daubenmire method, fleshy jaumea had the greatest total canopy cover and percent canopy cover during both the 2002 and 2003 monitoring years and fat-hen saltbush had the greatest frequency during both years.

*Success Criterion Evaluation*. Along Transect 1-1, the percent of non-native and invasive plant species is much less than 5 percent, and this success criterion has been met for this transect. However, transects 1-2 and 1-3 (both discussed below) marginally exceeded 5 percent cover of non-native or invasive plant species. Additional weed control is needed at this site to reduce the percent cover below the 5 percent threshold.

**Transect 1-2**

*Descriptive Analysis*. All 15 of the marsh quadrats sampled along Transect 1-2 contained vegetation (Data Table 3-15c, Appendix A). The species that occurred most frequently along the marsh transect was fat-hen saltbush. Of the 17 species observed along the transect, 12 are native and five are non-native.

Percent cover for each of the species occurring in the quadrats ranged from 0 percent (unvegetated) to 90 percent. Variation may be attributed to substrate, elevation and tides (duration of inundation and surface scouring), and the patchiness of some species. Seven species having relatively high percent cover (greater than 20 percent) within individual quadrats are:

- Lyngby's sedge;
- American bulrush (*Scirpus americanus*);
- Seacoast bulrush (*Scirpus maritimus*);
- Hooker's willow (*Salix hookeriana*);
- Seashore saltgrass;
- Red alder; and
- Fat-hen saltbush.

The average percent cover for all 17 species identified along this transect is presented in Data Table 3-15c, Appendix A. Fat-hen saltbush had the highest average percent cover (22.3 percent), while percent cover for Hooker's willow (15.7 percent) and American bulrush (11.9 percent) was relatively high.

Of the 15 quadrats along Transect 1-2, 11 were entirely within herbivory avoidance fencing, two were partially within the fencing, and two were completely outside of the fencing. Along this transect, fencing appears to have had little effect on species frequency or overall percent cover. The quadrats that fell outside of the fencing were immediately adjacent to it. Therefore, these quadrats may have captured areas in which vegetation had begun growing beyond the fencing, accounting for the apparent lack of effect.

Data taken along Transect 1-2 show an increase in the number of quadrats containing vegetation, from 14 of 15 quadrats in 2002 to 15 of 15 quadrats in 2003. The number of species observed along the transect decreased from 18 in 2002 to 17 in 2003. Fat-hen saltbush occurred most frequently within individual quadrats during both years.

*Daubenmire Method Analysis*. Plant cover was also analyzed using the Daubenmire cover class and midpoint method, as described in Appendix C. Data in Data Table 3-16b, Appendix A, show that along Transect 1-2, fat-hen saltbush, a native plant species, had the greatest total canopy cover (317.5), percent canopy cover (21.2 percent), and frequency (86.7 percent). The data also show that along Transect 1-2, total cover of native plant species (1,155) is considerably higher than for the non-native or invasive species (77.5), although the total percent cover of non-natives exceeds the 5 percent threshold for this criterion.

Based on results of the Daubenmire method, fat-hen saltbush had the greatest canopy cover, percent canopy cover, and frequency during both Year 1 (2002) and Year 2 (2003) monitoring.

*Success Criterion Evaluation*. Transect 1-2 marginally exceeded 5 percent cover of non-native or invasive plant species. Additional weed control is needed at this site to reduce the percent cover below the 5 percent threshold.

**Transect 1-3**

*Descriptive Analysis*. Data were collected for an additional transect, Transect 1-3, as part of the Year 2 (2003) monitoring. This information will be used for future comparisons of vegetation occurring along this transect. Of the 16 marsh quadrats sampled along Transect 1-3, eight contained vegetation (Data Table 3-15d, Appendix A). The species that occurred most

frequently along the marsh transect were pickleweed, fat-hen saltbush, and brass buttons. Of the six species observed along the transects, five are native and one is non-native.

Percent cover for each of the species occurring in the quadrats ranged from 0 percent (unvegetated) to 50 percent. Variation may be attributed to substrate, elevation and tides (duration of inundation and surface scouring), and the patchiness of some species. One species, fat-hen saltbush, had relatively high percent cover (greater than 20 percent) within individual quadrats.

The average percent cover for all six species occurring along Transect 1-3 is presented in Data Table 3-15d, Appendix A. The average percent cover of fat-hen saltbush (6.25) was much higher than for any of the other species.

All of the quadrats were within herbivory avoidance fencing. Of the 16 quadrats sampled, eight were unvegetated. Along this transect, species composition appears to be affected more by tidal surface scouring than fencing.

*Daubenmire Method Analysis*. Plant cover was also analyzed using the Daubenmire cover class and midpoint method, as described in Appendix C. Data in Data Table 3-16c, Appendix A, show that along Transect 1-3, fat-hen saltbush, a native plant species, had the greatest total canopy cover (90) and percent canopy cover (5.6 percent). However, both fat-hen saltbush and pickleweed occurred with the greatest frequency (18.8 percent). The data also show that along Transect 1-3, total cover of native plant species (132.5) is considerably higher than for non-native or invasive species (7.5), although the cover of non-natives and invasives marginally exceeds the 5 percent threshold for this criterion.

*Success Criterion Evaluation*. Transect 1-3 marginally exceeded 5 percent cover of non-native or invasive plant species. Additional weed control is needed at this site to reduce the percent cover below the 5 percent threshold.

### 3.2.5 Biological Success Criterion 3 – Marsh Development/Plant Vigor

*Introduction.* Stem height and shoot density, which were used to assess plant vigor, are shown in Data Tables 3-17 and 3-18 (Appendix A), respectively.

During Year 1 (2002) monitoring, stem height and shoot density data were collected for all marsh vegetation within a quadrat. Only sedges (*Scirpus* and *Carex* spp.) were sampled during Year 2 (2003) monitoring. Three sedges (American bulrush, seacoast bulrush, and Lyngby's sedge) were observed along the marsh transects. Only Transect 1-2 contained sampled vegetation.

*Descriptive Analysis.* Data taken along Transect 1-2 during Year 2 (2003) were compared to data taken along the same transect in Year 1 (2002). In Year 2, stem height varied between 12 and 17 in. for Lyngby's sedge, between 15 and 24 in. for seacoast bulrush, and between 12 and 48 in. for American bulrush. Shoot density varied between 38 and 173 shoots per quadrat for Lyngby's sedge, between 8 and 12 shoots per quadrat for seacoast bulrush, and between 2 and 152 shoots per quadrat for American bulrush. Plant vigor was expressed in quadrats both inside and outside of the herbivory avoidance fencing, i.e., the fencing appears to have had little effect on plant vigor.

Average stem height for Lyngby's sedge increased from 13.3 in. (2002) to 14.3 in. (2003), an increase of 8 percent. Average stem height for American bulrush increased from 21.0 in. (2002) to 33.0 in. (2003), an increase of 57 percent. Seacoast bulrush was not observed during the Year 1 (2002) monitoring.

Average stem density for Lyngby's sedge increased from 90.0 shoots per quadrat (2002) to 105.5 shoots per quadrat (2003), an increase of 17 percent. Average stem density for American bulrush increased from 77.3 shoots per quadrat (2002) to 86.8 shoots per quadrat (2003), an increase of 12 percent.

*Success Criterion Evaluation.* Results for Year 2 monitoring show that vigor has increased between 2002 and 2003 for both Lyngby's sedge and American bulrush. However, stem height and stem density have not exceeded the 80 percent success criterion. If American bulrush

continues to increase through next year, it may meet the stem height success criterion of 80 percent by the end of Year 3 (2004). Lyngby's sedge may also meet the success criterion in Year 3. However, there is no reference site for seacoast bulrush or American bulrush, which makes it difficult to reach a conclusion regarding success.

### 3.2.6 Biological Success Criterion 4 – Marsh Development/Herbivory Avoidance

In 2003, a much greater area of the Squally Beach site was protected by herbivory avoidance fencing than in 2002, and much of the fencing is now more sturdy. The fencing is made of rebar, wood stakes, metal chainlink, and low cross strings with cables above the string. Herbivory avoidance fencing encloses most of the marsh vegetation on the site, although marsh polygons MA, MB, MQ, and MP are entirely outside of the fencing (Figure 3-11). The fencing is generally intact, although some cross strings were broken.

*Success Criterion Evaluation*. Although some vegetation along the waterward side of the fence has been grazed, the affected vegetation is minimal and the structure appears to be working effectively, with little evidence of grazing or goose entry. In general, BSC 4 has been met for this site.

### 3.2.7 Biological Success Criterion 5 – Riparian Vegetation Survival

*Introduction*. The location of the riparian vegetation transect is shown on Figure 3-10. The location of each quadrat along the transect is shown in Data Table 3-14, Appendix A. Plant species identified in quadrats along the riparian transect are presented in Data Table 3-19, Appendix A.

*Descriptive Analysis*. The majority of planted species within the quadrats are surviving. Of the 25 quadrats that contained native shrub and/or tree species, three contained native shrubs and/or trees that were not surviving. Tree species noted as not surviving within the quadrats included one Pacific willow (*Salix lasiandra*). Shrub species noted as not surviving within the quadrats included two red elderberry (*Sambucus racemosa*).

Species that did well within the quadrats included oceanspray, red flowering currant (*Ribes sanguineum*), red-osier dogwood, rose, Hooker's willow, and red alder. These species were observed in between five and 20 quadrats and were surviving in 100 percent of the quadrats in which they were found.

Non-native and invasive Scot's broom was found in four quadrats during Year 1 monitoring and in two quadrats during Year 2 monitoring. Non-native and invasive Himalayan blackberry was found in 11 quadrats during Year 1 monitoring and in 19 quadrats during Year 2 monitoring.

*Daubenmire Method Analysis*. Data were also analyzed using the Daubenmire cover class and midpoint method. Data in Data Table 3-20, Appendix A, indicate that the herbaceous layer makes up the majority of total canopy cover, the greatest percent canopy cover, and the majority of the species composition. In the herbaceous layer, creeping buttercup (*Ranunculus repens*) provided the highest total canopy cover (367.5) and percent canopy cover (14.7 percent). Within the shrub layer, Himalayan blackberry had the greatest total canopy cover (280.0) and percent canopy cover (11.2 percent). In the tree layer, red alder had the highest total canopy cover (765.0) and percent canopy cover (30.6 percent).

*Success Criterion Evaluation*. The Year 2 (2003) monitoring results show a slight increase in mortality of native plants compared to Year 1 (2002). In 2002, two trees were observed to be dead within the quadrats; during the 2003 monitoring, three trees and shrubs were observed to be dead within the quadrats. Of the 105 shrub and trees species observed within the quadrats, 102 were surviving, for a percent survival of 97 percent. Therefore, the site meets the 75 percent survival success criterion at this time. However, invasive species such as Scot's broom and Himalayan blackberry are beginning to establish themselves within the riparian area.

### 3.2.8 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

*Introduction*. The areal extent of riparian vegetation is shown on Figure 3-10. The percent cover of vegetation and the dominant species present in each polygon are presented in Data Table 3-13, Appendix A. Twenty-five quadrats were sampled along a transect in the riparian habitat at

or near elevation +14 ft (+4.3 m) MLLW (Figure 3-10). The locations of each quadrat along the transect are shown in Data Table 3-14, Appendix A.

*Riparian Vegetation Mapping*. Commonly occurring plant species in the riparian habitat along Marine View Drive include Hooker's willow, red alder, rose, grasses, and forbs. On the "riparian islands" in the marsh area, the dominant plant species include rose, bird's-foot trefoil, pepperweed (*Lepedium* sp.), and fat-hen saltbush. Fat-hen saltbush is common in the adjacent marsh habitat and is encroaching into the "islands" of riparian habitat.

The areal cover of riparian vegetation along Marine View Drive (i.e., polygon RA) in Year 2 had not changed from that mapped in Year 1. The extent of riparian vegetation on the south and central "islands" (i.e., polygons RB and RC, respectively) was approximately the same in 2003 as in 2002. However, the riparian habitat mapped on the northern "island" in 2002 (polygon RD in the 2002 monitoring report) is now dominated by marsh vegetation (polygon MM), as shown on Figure 3-10 of this monitoring report.

*Descriptive Analysis*. Vegetative cover varied within each quadrat, ranging from 1 percent to 95 percent (Data Table 3-19, Appendix A). The data also show that 16 plant species had relatively high coverage (greater than 20 percent) within individual quadrats. Of those 16, nine were herbaceous, three were trees, and four were shrubs. The native plant species having relatively high coverage included:

- Sickle-keeled lupine;
- Red fescue (*Festuca rubra*);
- Red-osier dogwood;
- Rose;
- Hooker's willow; and
- Red alder.

*Daubenmire Analysis*. Data were also analyzed using the Daubenmire cover class and midpoint method, described in Appendix C. Data Table 3-20 (Appendix A) shows that herbaceous vegetation, much of which is non-native or invasive, composes much of the vegetation cover in

the riparian area. The herbaceous plant species with the greatest total canopy cover are creeping buttercup (367.5), common velvetgrass (*Holcus lanatus*) (265.0), redtop (237.5), bentgrass (142.5), and birds-foot trefoil (145.0). In the shrub layer, Himalayan blackberry, a non-native plant, has the highest total canopy cover (280.0), percent canopy cover (11.2 percent), and frequency (19.0 percent). In the tree layer, both Hooker's willow and red alder have relatively high cover. The total canopy cover for Hooker's willow is 715.0, the percent canopy cover is 28.6 percent, and the frequency is 19.0 percent. For red alder, the total canopy cover is 765.0, the percent canopy cover is 30.6 percent, and the frequency is 20 percent.

The total canopy cover of herbaceous vegetation decreased from 2,305 in Year 1 to 2,085 in Year 2, and the percent canopy cover of herbaceous vegetation decreased from 92.2 percent in Year 1 to 83.4 percent in Year 2. However, in both Year 1 and Year 2, herbaceous vegetation provided greater total canopy cover and percent canopy cover than did shrubs and trees, although the total canopy cover and percent canopy cover for both trees and shrubs increased considerably from 2002 to 2003. For shrubs, total canopy cover and percent canopy cover increased from 197.5 and 7.9 percent, respectively, in 2002 to 807.5 and 32.3 percent in 2003. For trees, total canopy cover and percent canopy cover increased from 437.5 and 17.5 percent, respectively, in 2002 to 1,545 and 61.8 percent in 2003.

*Success Criterion Evaluation*. The areal cover of native trees and shrubs has increased from the previous year. The Squally Beach site is proceeding toward meeting the minimum percent cover of trees, shrubs, and herbaceous vegetation by Year 3. However, greater control of non-native and invasive plant species will be needed to reduce the percent cover of such species to less than 2 percent.

### 3.2.9 Biological Success Criterion 9 – Bird Use

*Introduction*. The number of species observed on the Squally Beach site between April and November ranged from nine to 14 (Data Tables 3-21 and 3-22, Appendix A). The greatest number of bird species was observed in late May and late September, when 14 species were observed per visit. Use of riparian habitat was greatest in May and November, with five and four species observed, respectively. Avian use of the marsh, intertidal, and mudflat habitats

was greatest in spring (April, May, June) and late fall (November), with seven or eight species per visit. Open-water habitat was used by zero to six species per visit (Data Table 3-22, Appendix A).

Descriptive Analysis. Species observed in the greatest numbers per visit during the 2003 field surveys were American widgeon (243), mallard (66), European starling (44), and glaucous-winged gull (*Larus glaucescens*) (43) (Data Table 3-21, Appendix A). Glaucous-winged gull and mallard were the only species present during all ten site visits.

Waterfowl species observed at the Squally Beach site included American widgeon, bufflehead (*Bucephala albeola*), Canada goose, greater scaup (*Aythya marila*), green-winged teal (*Anas crecca*), mallard, and double-crested cormorant. Shorebird species included spotted sandpiper (*Actitis macularia*) and western sandpiper (*Calidris mauri*).

Obvious breeding/territorial behavior, such as singing, fighting, or pursuit, "broken-wing" distraction technique, the gathering of nesting material, and the presence of young, was observed in the following species:

- Purple martin (*Progne subis*);
- Song sparrow;
- Belted kingfisher (*Ceryle alcyon*); and
- Canada goose.

Species observed only in spring and early summer included purple martin and greater scaup. Purple martin, a Washington State priority species, was recorded as using nest boxes attached to pilings on and around the site for the second year. Autumn migrants included American goldfinch (*Carduelis tristis*), American widgeon (in large numbers), gadwall (*Anas strepera*), golden-crowned kinglet (*Regulus satrapa*), black-capped chickadee (*Poecile atricapilla*), and western sandpiper.

Raptor use of the site included a juvenile peregrine falcon (*Falco peregrinus*) (May) and an unidentified accipitor (September).

As was the case in 2002, tide level did not appear to significantly influence the number of species using the site.

*Success Criterion Evaluation*. BSC 9 is being met at the Squally Beach site based on the presence of numerous birds in a variety of species. Bird use is comparable to 2002 in number of recorded species, although the peak number of species recorded in the riparian habitat in 2003 is lower, decreasing from seven to five species.

## 3.3 Middle Waterway (Simpson/Trustees)

Information collected at the Middle Waterway (Simpson/Trustees) site included physical, vegetation (marsh and riparian), fish, invertebrate, and avian data. Ridolfi performed the topographic surveying and fish monitoring; NOAA Fisheries personnel participated in the fish monitoring; Adolfson performed the vegetation and avian monitoring; and NOAA personnel collected invertebrate data, which will be the subject of a separate report. The Middle Waterway (Simpson/Trustees) site data are discussed below in terms of the physical and biological success criteria applicable to the site for Year 2 monitoring.

### 3.3.1 Physical Success Criteria 4 – Elevation and Channel Morphology

Elevation and channel morphology at the Middle Waterway (Simpson/Trustees) site was evaluated by surveying eight cross sections approximately perpendicular to the long axis of the site (Figure 3-12). The cross sections are shown on Figures 3-13a through 3-13d. Each cross section also shows data collected in the 2000 as-built survey and the Year 1 (2002) survey.

*Success Criterion Evaluation*. Generally, the 2003 elevations agree with the 2002 elevations within 6 in. (150 mm) or less. One possible exception is the area beginning approximately 200 ft (60 m) from the north end, between cross-sections B-B' and D-D' (Figures 3-13a and 3-13b), where the contours appear to be shifting somewhat. With this limited exception, PSC 4 is being met at the Middle Waterway (Simpson/Trustees) site.

### 3.3.2 Biological Success Criterion 1 – Marsh Development/Areal Coverage

*Introduction*. The areal extent of marsh vegetation at the Middle Waterway (Simpson/Trustees) site is shown on Figure 3-14. The percent cover of vegetation in each polygon and the dominant species present are shown in Data Table 3-23, Appendix A. Twenty-three quadrats were sampled along the marsh transect at or near elevation +12 ft (+3.7 m) MLLW (Figure 3-14). The locations of each quadrat along each transect are shown in Data Table 3-24, Appendix A. The percent cover of vegetation in each quadrat is shown by species in Data Table 3-25, Appendix A.

*Marsh Vegetation Mapping*. Dominant marsh species included tufted hairgrass, seaside saltgrass, pickleweed, and fat-hen saltbush, although fleshy jaumea, seaside arrowgrass, and seaside plantain are also common. The patches of marsh vegetation in the southern and eastern portions of the site are typically found along the upper edge of the marsh habitat. Patches in the eastern portion of the site are predominately found within the herbivory avoidance fencing. The marsh vegetation in the northern portion of the site has more diverse, dense plant species, with vegetation occasionally growing beyond the fencing.

The marsh vegetation in the southern and eastern portions of the site have approximately the same areal cover as in Year 1 (2002). However, marsh vegetation in the northern portion of the site has increased since the Year 1 monitoring. Some of the increased areal cover may be attributed to the time of year in which the Year 2 survey was conducted (late summer in 2003 as opposed to early summer in 2002). However, it appears that new patches of marsh vegetation have become established since the Year 1 monitoring and that some of the patches identified last year have increased in areal extent.

*Daubenmire Method Analysis*. In 2003, the total canopy cover and percent canopy cover were 272.5 (267.5 native, 5.0 non-native) and 11.9 percent (11.6 percent native, 0.2 percent non-native), respectively. In 2002, the total canopy cover and percent canopy cover were 455 and 19.8 percent, respectively. The apparent decrease in overall marsh vegetation cover between Year 1 and Year 2 may be attributed to several factors. In 2003, more of the randomly placed quadrats occurred in completely unvegetated areas than in 2002. In addition, the random placement of

quadrats in 2003 resulted in no data collection from the larger, more diverse patches of vegetation near the north end of the site.

*Success Criterion Evaluation*. The mapping of areal marsh vegetation cover shows that the southern and eastern patches of vegetation are approximately the same in Year 2 as in Year 1 and that patches in the north end of the site have increased during the past year. However, the plot data indicate a decrease in vegetation cover. This may be because results for the randomly placed quadrats do not necessarily reflect site conditions in the northern portion of the site, where most of the increase in areal extent of vegetation occurred. Therefore, on the basis of marsh vegetation mapping, BSC 1 is assumed to have been met.

### 3.3.3 Biological Success Criterion 2 – Marsh Development/Species Composition

*Introduction*. The location of the marsh transect at the Middle Waterway (Simpson/Trustees) site is shown on Figure 3-14. The locations of each quadrat along the marsh transect are shown in Data Table 3-24, Appendix A. Plant species identified in each of the 23 quadrats along this transect are presented in Data Table 3-25, Appendix A. Information from that table was used to determine the frequency of occurrence for each species identified along the transect. The table also indicates whether plants are native or non-native.

*Descriptive Analysis*. Of the 23 marsh quadrats sampled along Transect 1-1, 11 contained vegetation. The species that occurred most frequently along the marsh transect was fat-hen saltbush, which occurred in eight of 23 quadrats. Of the four species observed along the transects, two are native and two are non-native.

Percent cover for each of the species occurring in the quadrats ranged from 0 percent (unvegetated) to 75 percent. Variation may be attributed to substrate, elevation and tides (duration of inundation and surface scouring), and the patchiness of some species. The two native species, which had relatively high percent cover (greater than 20 percent) within individual quadrats, are:

- Fat-hen saltbush; and
- Pickleweed.

The average percent cover for all four species identified along this transect is presented in Data Table 3-25, Appendix A. Native species pickleweed and fat-hen saltbush had the highest average percent cover at 6.0 and 6.6 percent, respectively. The average percent cover of the two non-native species, brome (*Bromus* sp.) and redtop, was less than 1.0 percent for both.

Of the 23 quadrats along this transect, one was completely within herbivory avoidance fencing, one was partially within the fencing, and 21 were completely outside the fencing. Because so few quadrats fell within the fenced areas, using transect data to make assessments regarding the overall effects of herbivory avoidance fencing on plant species composition is difficult. However, observations made by staff biologists suggest that herbivory avoidance fencing increased plant species diversity and plant cover of marsh vegetation.

Data taken along Transect 1-1 in Year 2 were compared to data taken along the same transect in Year 1. Both the number of quadrats containing vegetation and the number of species observed along the quadrats decreased. In 2002, 13 of 23 quadrats contained vegetation; in 2003, 11 of 23 quadrats contained vegetation. The number of species decreased from five in 2002 to four in 2003. Fat-hen saltbush occurred most frequently within individual quadrats in both years.

*Daubenmire Method Analysis*. Plant cover was also analyzed using the Daubenmire cover class and midpoint method, as described in Appendix C. Data in Data Table 3-26, Appendix A, show that along Transect 1-1, fat-hen saltbush, a native plant species, had the greatest total canopy cover (140), percent canopy cover (6.1 percent), and frequency (34.8 percent). The table also shows that along Transect 1-1, total canopy cover of native plant species (267.5) is considerably higher than for the non-native or invasive species (5.0).

Based on results of the Daubenmire method, seashore saltgrass had the greatest total canopy cover and percent canopy cover in Year 1, while fat-hen saltbush had the greatest total canopy cover and percent canopy cover in Year 2. Fat-hen saltbush had the greatest frequency during both years of monitoring.

*Success Criterion Evaluation*. Transect 1-1 had less than 5 percent cover of non-native or invasive plant species. Therefore, this criterion has been met at this site.

### 3.3.4 Biological Success Criterion 4 – Marsh Development/Herbivory Avoidance

Twelve herbivory avoidance structures occur in marsh habitats on the Middle Waterway (Simpson/Trustees) site. These consist of wood or rebar posts with chicken wire on the sides and cross strings and/or rope across the top. Vegetation at marsh polygons MB and MC extends beyond the fencing, while vegetation in marsh polygons MF, MG, MH, and MI is mostly limited to the fenced areas (Figure 3-15). Much of the vegetation in marsh polygon ME occurs within the fenced area, although the western projection of the fenced area is unvegetated. Vegetation in marsh polygons ML and MM has expanded beyond the fenced areas.

*Success Criterion Evaluation*. In general, the herbivory avoidance fencing is intact, except around marsh polygon MH. In that area, the strings are broken. However, all the devices appear to be working, because there is no evidence of waterfowl grazing and no use of the fenced areas was noted. Therefore, BSC 4 has been met at the Middle Waterway (Simpson/Trustees) site.

### 3.3.5 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

*Introduction*. The areal extent of riparian vegetation is shown on Figure 3-14. The percent cover of vegetation and the dominant species present in each polygon are presented in Data Table 3-23, Appendix A. Plot data were not collected along the riparian vegetation transect in 2003.

*Descriptive Analysis*. Dominant riparian vegetation in the northern portion of this site included black cottonwood (*Populus balsamifera*), Douglas fir, and rose. Along the eastern and southern sides of the site, the riparian vegetation was dominated by native species such as shore pine (*Pinus contorta*), black cottonwood, rose, and kinnikinnick (*Arctostaphylos uva-ursi*) and by non-native species such as butterfly bush (*Buddleja davidii*) and weedy species of grasses and forbs. The extent of aerial cover of riparian vegetation in Year 2 is the same as in Year 1.

*Success Criterion Evaluation*. The areal extent of vegetation on this site has stabilized. However, to meet the percent cover success criterion established for Year 3, control of non-native, invasive plant species is needed to reduce the percent cover to less than 2 percent.

### 3.3.6 Biological Success Criterion 7 – Fish Access/Presence

*Introduction*. The Middle Waterway (Simpson/Trustees) site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Data Table 3-27 (Appendix A). Fish sampling occurred once in April, biweekly from May through August, and monthly into October.

The customized fishing gear built for the project functioned as intended. Over the sampling period, 33 individual beach seine net sets were completed at the Middle Waterway (Simpson/Trustees) site during 11 sampling events. Beach seine sampling was conducted as described in Section 2.11.2. A fraction of the catch was retained by NOAA Fisheries for analysis of stomach contents and fish chemistry. The results of the analyses were not available at the time of this report.

*Descriptive Analysis*. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The SR per sampling event ranged from two to seven; 13 different species (total SR) were caught at the site during various sampling events, including four salmonid species. The Middle Waterway (Simpson/Trustees) site ranked fifth among the sites in SR (Figure 3-6a). SR at the site peaked in early July (Figure 3-5b). Shiner perch was the most abundant species present, followed by Pacific staghorn sculpin and surf smelt. Peak catches occurred for these three species from early May to early August. The complete catch results are listed in Data Table 3-28, Appendix A.

The most abundant salmonid species was chinook, which reached peak abundance in late April (Figure 3-7b). Chum were the second most abundant salmon encountered at the site. As with chinook, peak catches of chum salmon occurred in late April. The pink salmon catch peaked in mid-May, while the coho catch was fairly constant over the sampling season. No trout were caught during any of the sampling events. Table 5 summarizes the total catch and average per set (i.e., CPUE) for juvenile salmon caught at the Middle Waterway (Simpson/Trustees) site.

**Table 5. Summary of total juvenile salmon caught and average numbers of salmon per net observed at the Middle Waterway (Simpson/Trustees) site for Year 2 (2003) monitoring.**

| Species | Number of Salmon Caught | Average per Set/Catch per Unit Effort |
|---|---|---|
| Chinook | 46 | 1.39 |
| Coho | 6 | 0.18 |
| Chum | 30 | 0.91 |
| Pink | 10 | 0.30 |
| Total salmon | 92 | 2.78 |

*Success Criterion Evaluation*. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Middle Waterway (Simpson/Trustees) site.

### 3.3.7 Biological Success Criterion 9 – Bird Use

*Introduction*. The number of species observed at the Middle Waterway (Simpson/Trustees) site between April and November ranged from five to 15, with the greatest number of species occurring in May (14 and 15 species) and September (14 species) (Data Table 3-29, Appendix A). The fewest number of species was observed in April. The total number of species recorded increased from 30 in 2002 to 35 in 2003. The average number of species observed increased slightly from 10.4 in 2002 to 10.8 in 2003.

*Descriptive Analysis*. The number of species observed in the riparian habitat was greatest in August and September (five species present). Only one species was observed in the riparian habitat on June 13, 2003, and two species were observed on field visits in April and late September. As at the other sites, noise from the surrounding environment forced staff to rely on visual observations. Because birds can go unseen, yet their presence can be confirmed by sound, it is likely that more species are present in the riparian habitat than were recorded in this study; however, noise conditions are likely to be relatively similar from one year to the next, providing consistent monitoring conditions.

Use of the marsh and intertidal habitat was highest in June, with nine species present. The fewest number of species (three) was observed in late April (Data Table 3-30, Appendix A). Use of the open-water habitat at the site was variable, with zero to three species typically present.

The single species present during all field visits was glaucous-winged gull; house finch was present during nine of ten field visits. As was the case in 2002, glaucous-winged gull were observed in the greatest numbers, with up to 38 individuals observed in a single visit (Data Table 3-30, Appendix A).

Waterfowl species observed at the site in 2003 included American widgeon, Canada goose, and double-crested cormorant. Shorebird species included killdeer, least sandpiper (*Calidris minutilla*), and western sandpiper. Great blue heron were observed on five occasions.

Two raptor species were observed at the site: A juvenile peregrine falcon was seen striking at shorebirds on August 30, 2003, and a Cooper's hawk (*Accipter cooperii*) was observed on two occasions (in September and November) perching in the same tree at the north end of the site.

Bird species displaying obvious breeding/territorial behavior, such as singing, fighting, or pursuit, "broken-wing" distraction technique, the gathering of nesting material, and the presence of young, were:

- White-crowned sparrow;
- Killdeer; and
- House finch.

In 2003, three species were observed displaying breeding/territorial behavior, compared to five species in 2002.

Species observed on the site only in the spring included bushtit (*Psaltriparus minimus*), western tanager (*Piranga ludoviciana*), and spotted towhee (*Pipilo maculates*). Species observed only in the autumn included American widgeon, herring gull (*Larus argentatus*), Cooper's hawk, peregrine falcon, song sparrow, yellow warbler (*Dendroica petechia*), least sandpiper (*Calidris minutilla*),

and western sandpiper. Species counts were greatest in summer in both Year 2 (26) and Year 1 (20) and lowest in spring in both Year 2 (19) and Year 1 (13).

As was the case in 2002, tide level did not appear to influence the number of species observed using the site.

*Success Criterion Evaluation*. BSC 9 is being met at the site based on the presence of numerous birds in a variety of species. However, there is no reference site against which to make a definitive comparison.

## 3.4 Middle Waterway (City of Tacoma)

This site was evaluated by the City of Tacoma with the following exceptions: Ridolfi performed the topographic surveying and evaluated PSC 2 and PSC 4; fish data for evaluation of BSC 7 were collected by Ridolfi and NOAA Fisheries; and invertebrate data, which will be the subject of a separate report, were collected by NOAA personnel.

### 3.4.1 Physical Success Criterion 2 – Intertidal Stability

Intertidal stability at the Middle Waterway (City of Tacoma) site was evaluated by surveying the +10, +12, and +13.5 ft (+3.0, +3.7, and +4.1 m) contours. These contours are shown on Figure 3-16 along with contours from the 2000 design drawings, since no as-built survey was available, and the Year 1 (2002) survey. Differences between the 2000 design contours and the 2002 and 2003 survey contours are suspected to reflect differences between the design and constructed elevations. This is most likely in the upper reaches of the channels, which were probably not as smoothly contoured as designed. Nevertheless, differences can also be observed between the Year 1 and Year 2 surveyed contours; the site may still be stabilizing. There appears to be some localized slumping in the northeast corner near East "F" Street and along the Middle Waterway, as well as gradual filling or silting up of the channel beds created in the restoration work.

*Success Criterion Evaluation*. Despite the differences described above, it would appear that the requirements of PSC 2 are being generally met at the site.

### 3.4.2 Physical Success Criterion 4 – Elevation and Channel Morphology

Elevation and channel morphology at the Middle Waterway (City of Tacoma) site were evaluated by surveying six cross sections. The cross-sections are shown on Figures 3-17a through 3-17c. There are no as-built contours from 2000 against which the Year 2 results can be compared. However, based on a comparison to the Year 1 survey, there appears to be some filling of the constructed channels since last year. This may reflect ongoing stabilization.

*Success Criterion Evaluation*. For the moment, PSC 4 is not being met at the site.

### 3.4.3 Biological Success Criterion 7 – Fish Access/Presence

*Introduction*. The Middle Waterway (City of Tacoma) site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Data Table 3-31 (Appendix A). Fish sampling occurred once in April, biweekly from May through August, and monthly into October. A fraction of the catch was retained by NOAA Fisheries for analysis of stomach contents and fish chemistry. The results of the analyses were not available at the time of this report.

The customized block net fishing gear built for the project did not seem to function as intended. The block net was used from April through July, with a total of seven block net sets made. Due to lack of effectiveness with the block net, a beach seine was used at the site from August through October, with a total of six beach seine sets completed. Over the seven-month sampling period, 13 individual net sets were completed at the Middle Waterway (City of Tacoma) site during 11 sampling events. The block net design deployed at the site and the beach seine net are both described in Section 2.11.

*Descriptive Analysis*. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. Species richness per sampling event ranged from zero to four; a total of five different species (total SR) were caught at the site during various sampling events (Figure 3-6a). The Middle Waterway (City of Tacoma) site had the lowest SR of all six sites sampled for fish assemblage composition; SR peaked during the last sampling event in October (Figure 3-5c), most likely due to use of the beach seine, which seemed to have better

results than the block net at this site. Shiner perch was the most abundant species observed at the site, with the peak occurring in early August, although no shiner perch were caught during first two sampling events in late April and early May. Catches for staghorn sculpin peaked in mid-June and surf smelt numbers peaked in mid-September.

A single pink salmon, caught in late May with the block net, represented the only salmonid species observed at the Middle Waterway (City of Tacoma) site. No trout were caught. Table 6 summarizes the total catch and average per set (i.e., CPUE) for juvenile salmon caught at the Middle Waterway (City of Tacoma) site.

**Table 6. Summary of total juvenile salmon caught and average numbers of salmon per net observed at the Middle Waterway (City of Tacoma) site for Year 2 (2003) monitoring.**

| Species | Number of Salmon Caught | Average per Set/Catch per Unit Effort |
|---|---|---|
| Pink | 1 | 0.08 |
| Total salmon | 1 | 0.08 |

The catch results for this site are listed in Data Table 3-32, Appendix A.

*Success Criterion Evaluation*. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Middle Waterway (City of Tacoma) site.

## 3.5 Yowkwala

Information collected at the Yowkwala site included marsh vegetation, fish, and invertebrate data. Adolfson collected the vegetation data, Ridolfi and NOAA Fisheries personnel obtained the fish data, and NOAA personnel collected the invertebrate data, which will be the subject of a separate report.

### 3.5.1 Biological Success Criterion 1 – Marsh Development/Areal Coverage

*Introduction*. The areal extent of marsh vegetation at the Yowkwala site is shown on Figure 3-18. The percent cover of vegetation in each polygon and the dominant species present are included in Data Table 3-33, Appendix A. Year 2 (2003) was the first year in which data on vegetation

areal coverage were collected at this site. The Year 2 data are from mapped polygon data; no transect plot data were collected.

*Descriptive Analysis*. Fat-hen saltbush was the dominant plant in the patches of marsh vegetation interspersed along the upper edge of the beach. Other species that occurred in the marsh habitats are ryegrass (*Elymus* sp.), gumweed (*Grindelia integrifolia*), and seaside saltgrass. Pepperweed from adjacent riparian habitats provide cover, but is generally not rooted in the marsh habitats.

*Success Criterion Evaluation*. Because no comparison can be made of year-to-year data, BSC 1 cannot be evaluated for the Year 2 monitoring.

### 3.5.2 Biological Success Criterion 7 – Fish Access/Presence

*Introduction*. The Yowkwala site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Data Table 3-34 (Appendix A). Fish sampling occurred once in April, biweekly from May through August, and monthly into October. A fraction of the catch was retained by NOAA Fisheries for analysis of stomach contents and fish chemistry. The results of the analyses were not available at the time of this report.

The customized fishing gear built for the project functioned as intended. Over the seven-month sampling period, 33 individual net sets were completed at the Yowkwala site during a total of 11 sampling events. Beach seine sampling was conducted as described in Section 2.11.

*Descriptive Analysis*. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The SR per sampling event ranged from two to nine; 21 different species (total SR) were caught at the site during various sampling events. The Yowkwala site had the third-highest SR for the sampling season (Figure 3-6a), and the number of different species observed at the site peaked in early June (Figure 3-5d). Coho salmon was the most abundant species observed at the Yowkwala site, followed by surf smelt and shiner perch. The catch results for Yowkwala are listed in Data Table 3-35, Appendix A.

Six salmonid species were observed, including steelhead and cutthroat trout. The peak salmonid catch occurred in early April, and no juvenile salmon or trout were caught after mid-July. Coho were the most abundant salmonid species, peaking in early May. The chinook catch peaked in mid-April (Figure 3-7c). Peak numbers for pink salmon also occurred in mid-April, while peak numbers for chum salmon occurred in early May. Eighteen cutthroat trout were sampled at the site, with peak numbers occurring in early May. Four steelhead trout were caught, with peaks occurring in late June. Table 7 summarizes the total catch and average per set (i.e., CPUE) for juvenile salmon caught at the Yowkwala site.

**Table 7. Summary of total juvenile salmon caught and average numbers of salmon per net observed at the Yowkwala site for Year 2 (2003) monitoring.**

| Species | Number of Salmon Caught | Average per Set/Catch per Unit Effort |
|---|---|---|
| Chinook | 88 | 2.67 |
| Coho | 367 | 11.1 |
| Chum | 22 | 0.67 |
| Pink | 87 | 2.64 |
| Total salmon | 564 | 17.1 |

Although only juvenile salmon were counted, it is of interest to note that approximately 200 adult pink salmon were caught in the first set during the mid-August sampling event. The adults were using the site as a "staging area," an area in which adult salmon congregate before returning to their freshwater spawning grounds. Adult salmon hold in nearshore estuarine waters close to the mouth of their natal stream. Once water conditions such as depth, temperature, and flow are optimal in the natal stream, the salmon enter the river and return to their spawning grounds.

*Success Criterion Evaluation*. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Yowkwala site.

## 3.6 Skookum Wulge

In accordance with the work plan (Ridolfi and Adolfson, 2001), only two criteria were monitored at the Skookum Wulge site for Year 2. Ridolfi and NOAA Fisheries personnel obtained fish data, and NOAA personnel collected invertebrate data, which will be the subject of a separate report.

### 3.6.1 Biological Success Criterion 7 – Fish Access/Presence

*Introduction*. The Skookum Wulge site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Data Table 3-36 (Appendix A). Fish

sampling occurred once in April, biweekly May through August, and monthly into October. A fraction of the catch was retained by NOAA Fisheries for analysis of stomach contents and fish chemistry. The results of the analyses were not available at the time of this report.

The customized fishing gear built for the project functioned as intended. Over the seven-month sampling period, 12 individual net sets were completed at the Skookum Wulge site during a total of 11 sampling events. Beach seine sampling was conducted as described in Section 2.11.

*Descriptive Analysis*. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The SR per sampling event ranged from one to seven; 13 different species (total SR) were caught at the site during various sampling events. Species richness was fairly constant, with peak numbers of species observed in mid-July (Figure 3-5e). The Skookum Wulge site had the fourth-highest SR for the sampling season (Figure 3-6a). Shiner perch and coho salmon were the most abundant species, with peak catches in early June and late May, followed by surf smelt that peaked in early August. The catch results for the Skookum Wulge site are listed in Data Table 3-37, Appendix A.

Five salmonid species were present at the site, including cutthroat trout, and salmon and trout were encountered during every sampling event except the last three (mid-August to mid-October). Coho was the most abundant salmon species observed, with the peak catch occurring in late May. Peak catches of chinook salmon (Figure 3-7d) and cutthroat occurred in early May. Peak catches of chum and pink salmon occurred in late May. Table 8 summarizes the total catch and average per set (i.e., CPUE) for juvenile salmon caught at the Skookum Wulge site.

**Table 8. Summary of total juvenile salmon caught and average numbers of salmon per net observed at the Skookum Wulge site for Year 2 (2003) monitoring.**

| Species | Number of Salmon Caught | Average per Set/Catch per Unit Effort |
|---|---|---|
| Chinook | 49 | 4.08 |
| Coho | 124 | 10.33 |
| Chum | 17 | 1.42 |
| Pink | 4 | 0.33 |
| Total salmon | 194 | 16.16 |

*Success Criterion Evaluation*. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Skookum Wulge site.

## 3.7 Olympic View

In accordance with the work plan (Ridolfi and Adolfson, 2001), fish monitoring conducted by Ridolfi and NOAA Fisheries personnel was the only monitoring activity for the Olympic View site in Year 2.

### 3.7.1 Biological Success Criteria 7 – Fish Access/Presence

*Introduction*. The Olympic View site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Data Table 3-38 (Appendix A). Fish sampling occurred once in April, biweekly May through August, and monthly into October. A fraction of the catch was retained by NOAA Fisheries for analysis of stomach contents and fish chemistry. The results of the analyses were not available at the time of this report.

The customized fishing gear built for the project functioned as intended. Over the seven-month sampling period, 28 individual net sets were completed at the Olympic View site during a total of 11 sampling events. Beach seine sampling was conducted as described in Section 2.11.

*Descriptive Analysis*. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The Olympic View site had the highest SR of all the sites (Figure 3-6a). The SR per sampling event ranged from one to 11; 26 different species (total SR), including four salmonid species, were caught at the Olympic View site during various sampling events. The peak number of species observed occurred in early May (Figure 3-5f). Shiner perch and staghorn sculpin had peak catches during early June, while the surf smelt catch peaked in late August. The catch results for the Olympic View site are listed in Data Table 3-39, Appendix A.

The most abundant salmonid species at the Olympic View site was chum, with peak catches occurring during the late May sampling event. The chinook salmon catch peaked in early June

(Figure 3-7e). Pink salmon were present at the site, with peak catches in late June. One coho salmon was caught in late July. Steelhead and cutthroat trout were not observed during any of the sampling events. Table 9 summarizes the total catch and average per set for juvenile salmon caught at the Olympic View site.

**Table 9. Summary of total juvenile salmon caught and average numbers of salmon per net observed at the Olympic View site for Year 2 (2003) monitoring.**

| Species | Number of Salmon Caught | Average per Set/Catch per Unit Effort |
|---|---|---|
| Chinook | 64 | 2.29 |
| Coho | 1 | 0.04 |
| Chum | 105 | 3.75 |
| Pink | 3 | 0.11 |
| Total salmon | 173 | 6.19 |

*Success Criterion Evaluation*. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Olympic View site.

## 4. DISCUSSION OF FISH MONITORING TO DATE

Sampling logistics for both seasons (Year 1 and Year 2) were challenging for many reasons. The site-to-site variation in physical characteristics, such as topography, elevation, currents, and location, and the distance between sites made timing sampling events with the appropriate tide cycle difficult. However, the gear generally functioned as intended during both seasons, and sampling efforts were successful. Because of differences in habitat, the gear used, and the areas sampled, it is important to be cautious when comparing catch results among sites and from year to year. With that in mind, both seasons showed fish abundance and assemblage in all six of the restoration sites studied. Juvenile salmonids and forage fish were also observed at the restoration sites during Year 1 and Year 2.

Data from the six sites sampled for fish assemblage in Year 2 were analyzed and compared to data from Year 1. This comparison was made to determine trends in fish abundance and assemblage over time at the restoration sites. The total catch data from both seasons were analyzed to compare species richness. The catch per unit effort and mean average length for salmonids (chinook, coho, chum, and pink) in both seasons provided a means for comparing salmonid use of the restoration sites over time.

Two sites (Squally Beach and Tahoma Salt Marsh) sampled for fish assemblage in Year 1 were deleted for fish assemblage monitoring in the Year 2 work plan. The Squally Beach site was not sampled in 2003 because it was inaccessible by boat and fish abundance was low, with no salmon caught there during the Year 1 sampling season. The Tahoma Salt Marsh was not sampled in 2003 because of difficulties in scheduling sampling events to fit with appropriate tides. The Tahoma Salt Marsh site can be sampled effectively only below a –1 ft (–0.3 m) tide (MLLW), and, in any case, the site had not yet been restored.

Table 10 summarizes total catch data for Year 2. Table 11 summarizes the number of sets completed during the Year 2 sampling season by site (128 sets total, as compared to 108 sets in Year 1).

**Table 10. Commencement Bay fish and total catch for Year 2 (2003) monitoring.**

| Common Name | Scientific Name | Total Catch |
|---|---|---|
| bay pipefish | *Syngnathus leptorhynchus* | 17 |
| buffalo sculpin | *Enophrys bison* | 4 |
| cabezon sculpin | *Scorpaenichthys marmoratus* | 1 |
| chinook salmon | *Oncorhynchus tshawytscha* | 256 |
| chum salmon | *Oncorhynchus keta* | 222 |
| coho salmon | *Oncorhynchus kisutch* | 499 |
| crescent gunnel | *Pholis laeta* | 24 |
| cutthroat | *Oncorhynchus clarki* | 35 |
| English sole | *Pleuronectes vetulus* | 1 |
| northern sculpin | *Icelinus borealis* | 1 |
| Pacific herring | *Clupea pallasii* | 19 |
| Pacific sandlance | *Ammodytes hexapterus* | 4 |
| Pacific staghorn sculpin | *Leptocottus armatus* | 2,228 |
| penpoint gunnel | *Apodichthys flavidus* | 26 |
| pile perch | *Rhacochilus vacca* | 17 |
| pink salmon | *Oncorhynchus gorbuscha* | 106 |
| rock sole | *Pleuronectes bilineatus* | 14 |
| saddleback gunnel | *Pholis ornata* | 78 |
| sailfin sculpin | *Nautichthys oculofasciatus* | 1 |
| shiner perch | *Cymatogaster aggregata* | 39,793 |
| snake prickleback | *Lumpenus sagitta* | 26 |
| starry flounder | *Platichthys stellatus* | 359 |
| steelhead | *Onchorynchus mykiss* | 4 |
| striped perch | *Embiotoca lateralis* | 4 |
| sturgeon poacher | *Podothecus acipenserinus* | 1 |
| surf smelt | *Hypomesus pretiosus* | 1,325 |
| threespine stickleback | *Gasterosteus aculeatus* | 274 |
| tidepool sculpin | *Oligocottus maculosus* | 75 |
| tubesnout | *Aulorhynchus flavidus* | 4 |
| unidentified salmon | *Oncorhynchus* sp. | 1 |
| unknown flatfish | | 2 |
| unknown sculpin | | 112 |

**Table 11. Commencement Bay total fishing sets for Year 2 (2003) monitoring.**

| *Site Name* | *Gear Type* | *April 15* | *April 21-22* | *May 5-6* | *May 9* | *May 20-21* | *June 5-6* | *June 18-19* | *July 2-3* | *July 17-18* | *Aug 1* | *Aug 6* | *Aug 15* | *Aug 19* | *Sept. 16-17* | *Oct. 15* | **Totals** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mowitch | BN | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | | **9** |
| Middle Waterway (Simpson/Trustees) | BS | | 3 | 3 | | 3 | 3 | 3 | 3 | 3 | | 3 | | 3 | 3 | 3 | **33** |
| Middle Waterway (City of Tacoma) | BN | | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | | | | | | | **7** |
| Middle Waterway (City of Tacoma) | BS | | | | | | | | | | 2 | | | 1 | 1 | 2 | **6** |
| Yowkwala | BS | 3 | | 3 | | 3 | 3 | 3 | 3 | 3 | 3 | | 3 | | 3 | 3 | **33** |
| Skookum Wulge | BS | 1 | | | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | **12** |
| Olympic View | BS | 1 | | 2 | | 3 | 3 | 3 | 3 | 3 | | 3 | | 3 | 1 | 3 | **28** |
| **Totals** | | **5** | **5** | **10** | **2** | **12** | **12** | **12** | **12** | **12** | **7** | **6** | **5** | **7** | **9** | **12** | **128** |

**Notes:**

BN = block net
BS = beach seine net

A comparison of Year 1 and Year 2 data shows a similar trend in SR for each site (Figure 4-1). The total number of species peaked in late spring/early summer (Figure 4-2). Species richness was slightly higher during the 2002 season, with a total of 36 species observed at the sites over time as compared to 31 species in 2003.

The Olympic View site had the highest SR in both years. This is likely due to the eelgrass beds located offshore, which provide habitat for a wide variety of species. In 2002, the Yowkwala site had the second-highest SR; the Mowitch site ranked second in SR in 2003. The Middle Waterway (City of Tacoma) site had the lowest SR in both years. Differences in SR among these sites may be related to their locations throughout Commencement Bay. The Mowitch, Yowkwala, and Olympic View sites are on historical and modern outmigration routes (Figure 4-3) (Graeber, 1999, as cited in Simenstad, 2000), whereas the Middle Waterway (City of Tacoma) site is farther inland and highly industrialized. Large ships docked in the Middle Waterway create overwater structures that might interfere with fish migration. In addition, during a 2003 dredging project in the Middle Waterway, a silt curtain was at times placed across the waterway and may have blocked or interfered with fish migration. Further, the Middle Waterway is dry for a few hours twice per day because of elevation and changes in tide height; sampling generally occurred around high tide, and fish may not have reached or may have left the upper end of the waterway by the time sampling was completed.

Shiner perch was the most abundant species in both years and were observed at every site during both sampling seasons. This was expected, as shiner perch are resident fish in the Puget Sound region. Shiner perch also have one of the broadest distributions of all perch species found along the Pacific coast and use bays and estuaries as nurseries (Froese and Pauly, 2003).

In Year 1 (2002), coho was the second most abundant species for the sampling season. The majority of these coho were caught during mid-May on two consecutive days at the Yowkwala site. The large numbers probably relate to hatchery releases from the Puyallup River basin. In a study of the Duwamish estuary in 1995, it was found that a large pulse of juvenile chinook observed in May was related to a hatchery release from the Green River basin (Warner and Fritz, 1995, as cited in KCDNR, 2001).

Coho likely congregate at the Yowkwala site because of food availability, protection from predators, and the site's location within Commencement Bay. The Yowkwala site is on the outer reaches of the historical and modern outmigration path for salmonids (Figure 4-3) (Graeber, 1999, as cited in Simenstad, 2000). The site consists of a sloping beach with small cobbles to larger boulders, offering both food and hiding places. Compared to the other five sites, the Yowkwala site has the least amount of industrial development, with a highly vegetated beach and headlands. In addition, the Yowkwala site experiences some of the highest currents of all six sites during tidal cycles. These currents provide food and well-oxygenated waters and likely carry outmigrating salmonids into the area of the Yowkwala site.

Pacific staghorn sculpin, a resident fish, was the second most abundant species for 2003 and the third most abundant for 2002. The largest quantities of Pacific staghorn sculpin were caught at the Middle Waterway (Simpson/Trustees) site in 2003 and at the Mowitch site in 2002. Both sites have fine, light substrates, creating mudflat habitat with calm waters. Surf smelt were the third most abundant species in 2003, with the highest numbers observed at the Middle Waterway (Simpson/Trustees) site. The surf smelt found there were generally smaller than the surf smelt encountered at other sites, indicating the smelt were using the Middle Waterway (Simpson/Trustees) site as a nursery.

Juvenile salmon (chinook, coho, chum, and pink) were encountered at all sites during both sampling seasons. A comparison of Year 1 and Year 2 data showed peak abundances of salmon occurring in late spring/early summer (Figure 4-4). The peak numbers of salmon were observed in early May during 2003, as opposed to late May in 2002. The peak for both seasons occurred over a two-day period. Overall, greater numbers of salmon were observed in 2002 (Figure 4-5). Salmon numbers for 2003 may be lower as a result of infrequent sampling events, since constraints inherent to the study design mean that fish monitoring does not always occur concurrent with the peak runs.

The majority of cutthroat trout sampled over both seasons was caught at the Yowkwala and Skookum Wulge sites, with 2003 having the highest counts. Steelhead were also observed at these two sites in 2003, while no steelhead were caught at them in 2002.

As discussed above, the greatest numbers of coho and chinook salmon were observed at the Yowkwala site in both seasons. During 2002 and 2003, chinook peaked at the latest time. Although chinook had the broadest temporal distribution in 2002, the data showed fairly uniform temporal distribution of chinook and coho during the 2003 sampling season. Data for both seasons show a definite decline in salmon observed after late July. During both Year 1 and Year 2, the Yowkwala and Skookum Wulge sites had the greatest number of salmon observed. In Year 1, the Olympic View site had the fewest number of salmon observed, while in Year 2 the Middle Waterway (City of Tacoma) site had the fewest number of salmon (one pink) observed (Figure 4-5).

In both 2002 and 2003, the majority of chinook and coho observed at the sites were hatchery fish. Seventy-eight percent of chinook caught in 2002 were hatchery marked, as opposed to 65 percent in 2003 (Figure 4-6). Three percent of coho caught in 2002 were identified as hatchery marked, as opposed to 41 percent in 2003 (Figure 4-7). However, sampling procedures may be behind the differences in hatchery marked fish for the two years. During the Year 1 sampling, large numbers of coho (more than 1,000) were caught, most of them at the Yowkwala site over a two-day period in May. Forty-four of the fish were examined to determine species, length, and markings. To expedite the sampling procedure and ensure the coho were not harmed, the overall count was then estimated on the basis of the 44 coho examined as a representative sample. In making that estimate, no assumptions were made about hatchery markings. As a result, 96 percent of the catch is identified as "not checked" for markings. In contrast, approximately 50 percent more coho were checked for markings in Year 2 than in Year 1.

Chinook mean average lengths for both seasons (Figure 4-8) show evidence of multiple life history types migrating through and possibly rearing within the system. Coho mean average lengths for the two seasons were fairly similar over time (Figure 4-9), indicating a transitory and uniform population moving through the system. During both seasons, chum and pink salmon increased in size over time (Figures 4-10 and 4-11), indicating both species may have been using the sites for rearing.

## 5.0 SUMMARY AND RECOMMENDATIONS

### 5.1 Monitoring Summary and Other Observations for Selected Sites

Table 12 summarizes how the seven restoration sites have performed during Year 2 at achieving the PSCs and BSCs applicable for this monitoring period.

**Table 12. Performance summary for Year 2 (2003) monitoring.**

| | Physical Success Criteria | | | | Biological Success Criteria | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Site Name** | Intertidal Areal Coverage | Intertidal Stability | Tidal Circulation | Elevation and Channel Morphology | Marsh Development/Areal Coverage | Marsh Development/Species Composition | Marsh Development/Plant Vigor | Marsh Development/Herbivory Avoidance | Riparian Vegetation Survival | Riparian Vegetation/Areal Coverage | Fish Access/Presence | Invertebrate Prey Resource Production | Bird Use |
| Mowitch | | Y | Y | Y | Y | N | + | Y | Y | + | Y | ?[1] | Y |
| Squally Beach | | Y | | Y | Y | N | + | Y | Y | + | | | Y |
| Middle Waterway (Simpson/Trustees) | | | | Y | Y | Y | | Y | | + | Y | ?[1] | Y |
| Middle Waterway (City of Tacoma) | | Y | | N | | | | | | | Y | ?[1] | |
| Yowkwala | | | | | ?[2] | | | | | | Y | ?[1] | |
| Skookum Wulge | | | | | | | | | | | Y | ?[1] | |
| Olympic View | | | | | | | | | | | Y | | |

**Notes:**
Y = Criterion met
+ = Criterion not met but improving
N = Criterion not met, no trend assessed
? = Results not yet available
[1] Will be the subject of a separate report
[2] First year of monitoring; assessing progress will require comparison to subsequent monitoring phases

### 5.1.1 Mowitch

The Mowitch site is physically stable (PSC 2 and PSC 4), and tidal circulation is unimpeded (PSC 3). Areal cover for marsh (BSC 1) and riparian (BSC 6) vegetation is increasing on the site. Although the areal cover of trees and shrubs has increased, additional plantings may be needed to meet the riparian vegetation survival requirements (BSC 5). In addition, non-native and invasive plant species occur on the site in excess of the minimum thresholds (BSC 2 and BSC 6).

The herbivory avoidance fencing appears to be intact and effective (BSC 4). There was little to no obvious indication of waterfowl foraging on marsh plants. This may explain, in part, the increase in plant vigor (BSC 3) for sedges on the site.

Average SR per catch was highest at the Mowitch site, and total SR was second highest (Figure 3-6a). Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Mowitch site. Based on the presence of numerous birds in a variety of species, BSC 9 is also being met at the site. However, there is no reference site against which to make a definitive comparison.

### 5.1.2 Squally Beach

The Squally Beach site appears physically stable (PSC 2 and PSC 4), except in one limited area: the eastern channel directly south of the rockbox outlet (near cross-section B-B', Figure 3-9a), where a channel approximately 1 ft deep has eroded. This is the same area that was noted as eroding in the Year 1 monitoring report. At that time, it was recommended that a small quantity (less than 1 cubic yard) of cobbles (2 to 4 in. [50 to 100 mm] diameter) be placed in the rill and that the water be redirected across the marsh bench to the west, creating a longer, slower flow path. We maintain these recommendations.

Areal cover for marsh (BSC 1) and riparian (BSC 6) vegetation is increasing on the site. However, non-native and invasive plant species occur on the site in excess of the thresholds (BSC 2 and BSC 6). The survival of plant species in the riparian habitats meets the 75 percent threshold (BSC 5).

The herbivory avoidance fencing appears to be intact and effective (BSC 4); minimal grazing of marsh vegetation was observed. This may partially explain the increase in plant vigor (BSC 3) for sedges on the site.

Based on the presence of numerous birds in a variety of species, BSC 9 is being met at the site. However, there is no reference site against which to make a definitive comparison.

### 5.1.3 Middle Waterway (Simpson/Trustees)

Although a direct comparison with historical survey data was not possible, there are no signs of major physical instability (PSC 4) based on a comparison with the 2002 survey work. Some shifting is occurring on the northeastern portion of site; the shifting may be associated with redirected wave energy, since logs have been placed to protect nearby marsh vegetation. This area should be periodically inspected to evaluate the need for corrective action.

The areal extent of marsh (BSC 1) and riparian (BSC 6) vegetation is remaining stable, and therefore, meets the minimum requirements. Non-native and invasive plant species comprise less than 5 percent of the marsh vegetation cover on the site (BSC 2). Herbivory avoidance fencing appears to be intact and effective (BSC 4); little to no grazing was observed.

The surf smelt found at the Middle Waterway (Simpson/Trustees) site were generally smaller than the surf smelt encountered at other sites, suggesting that they use the site as a nursery. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Middle Waterway (Simpson/Trustees) site. Based on the presence of numerous birds in a variety of species, BSC 9 is also being met at the site. However, there is no reference site against which to make a definitive comparison.

### 5.1.4 Middle Waterway (City of Tacoma)

Differences can be observed between the Year 1 and Year 2 surveyed contours; the site may still be stabilizing. Despite those differences, however, it would appear that the requirements of PSC 2 are being met at the site. There is some localized slumping in the northeast corner near East "F" Street and along the Middle Waterway and gradual filling or silting up of the channel

beds created in the restoration work (PSC 4). We recommend evaluating this site in detail to select erosion protection measures.

The Middle Waterway (City of Tacoma) site had the lowest fish SR in both Year 1 and Year 2 (BSC 7). The site is situated farther inland than sites showing more fish abundance, and the area is highly industrialized. Elevation, tide height, dredging, ships, and overwater structures all may be factors interfering with fish migration in this area. Nevertheless, based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Middle Waterway (City of Tacoma) site.

#### 5.1.5 Yowkwala

There is no Year 1 marsh vegetation data for the Yowkwala site. However, based on observations made during the field study, the small patches of marsh plants interspersed on the site appear stable (BSC 1).

The Yowkwala site had the greatest numbers of salmonids (Figure 4-5), including coho and chinook salmon and cutthroat trout. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Yowkwala site.

#### 5.1.6 Skookum Wulge

The Skookum Wulge site was the second most productive for salmonids (Figure 4-5). Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Skookum Wulge site.

#### 5.1.7 Olympic View

The Olympic View site had the highest overall fish SR in both Year 1 and Year 2. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Olympic View site.

### 5.2 Monitoring and Adaptive Management Recommendations

Based on results of the Year 2 monitoring of restoration sites near Commencement Bay, we have the following recommendations:

- Place cobbles in a developing rill at the Squally Beach site and redirect the water across the marsh bench to the west, creating a longer, slower flow path.

- Design erosion protection measures for the Middle Waterway (City of Tacoma) site.

- Plant additional trees and shrubs at the Mowitch site to meet requirements for riparian vegetation survival.

- Provide additional weed control at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites to reduce non-native/invasive plant encroachment in both riparian and marsh areas.

- Control non-native/invasive plants along the eastern side of the Squally Beach site to ensure that these plants do not take over the planted riparian areas, as they have done on the forested lot immediately adjacent to the site. At the time of the field work, these plants were beginning to encroach onto the Squally Beach riparian habitat.

- On the field data form, group all non-native herbaceous vegetation in the riparian areas into a single category called "non-native/invasive herbs." Doing so will reduce the time it takes to collect riparian data and provide a better means of analyzing the field data. Non-native, invasive plants of concern, such as pepperweed and white sweet-clover, would not be included in this group, but would continue to be specifically listed and identified on the field data forms.

- Reduce the size of the riparian quadrat to about 3.3 ft x 6.5 ft (1 m x 2 m). The quadrat currently in use is larger and can extend beyond the riparian area into marsh vegetation. Although this is rare, selecting a slightly smaller quadrat would ensure that only planted riparian vegetation occurs within the quadrat, and the quadrat would still be of sufficient size to capture the planted riparian vegetation data.

- Remove garbage that has accumulated on some of the sites, not only for aesthetic reasons, but also to increase the potential for new vegetation to establish and to increase habitat value for wildlife.

- Incorporate general or overall site observations made during the field study into the yearly monitoring report. Currently, the random-quadrat study design means that some interesting and potentially significant changes may not be captured and described.

- Conduct fish monitoring events weekly from early March to late June. This would increase the chances of documenting the peak migration of salmonids.

- Use the beach seine net at the Middle Waterway (City of Tacoma) site instead of the block net. The block net was ineffective at this site in 2003. Using the beach seine net during the latter half of the 2003 sampling season resulted in larger catches and less harm to the fish.

- Use fyke nets, live boxes, or other fishing methods at the Mowitch site. (Fyke nets are large hoop nets that act as funnels to trap swimming fish.) During peak catches, block nets result in trauma and death to numerous fish. Changing fishing methods would reduce harm to fish and result in more accurate sampling.

- Determine an allowable percentage of daily salmonid catch to be taken for chemical analysis, so that the total catch of salmonids is not taken when salmonid presence is low.

## 6.0 REFERENCES

Adams, D. 2002. Personal communication with Colin Wagoner, Ridolfi Inc.

City of Tacoma. 2001. *Habitat Monitoring Report: Year 0 City of Tacoma Middle Waterway Restoration Project and Pickleweed Ranch*.

Cordell, J.R., L.M. Tear, K. Jensen, and H.A. Higgens. 1999. *Duwamish River Coastal America Restoration and Reference Sites: Results from 1997 Monitoring Studies*. Reprint FRI-UW-9903. Fisheries Research Institute, University of Washington.

Commencement Bay Natural Resource Trustees (Trustees). 2000. *Commencement Bay Natural Resource Damage Assessment Restoration Monitoring Plan*. Prepared by the National Oceanic and Atmospheric Administration, the U.S. Department of Interior and the State of Washington.

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. *Measuring and Monitoring Plant Populations*. BLM Technical Reference 1730-1. U.S. Department of the Interior, Bureau of Land Management and The Nature Conservancy.

Froese, R. and D. Pauly, Editors. 2003. *FishBase*. Online database. Available: <http://www.fishbase.org/>.

King County Department of Natural Resources (KCDNR). 2001. *Reconnaissance Assessment of the State of the Nearshore Ecosystem: Eastern shore of Central Puget Sound, including Vashon and Maury Islands*. Available: <http://dnr.metrokc.gov/wlr/watersheds/puget/nearshore/sonr.htm>.

Parametrix, Inc. 2002. *Middle Waterway Post-Construction (Year 5) Shore Restoration Project Monitoring and Adaptive Management Plan Data Report*. Prepared for Simpson Tacoma Land Company and International Paper Company. March.

Rice, C.A., D.P. Lomax, T.K. Collier, and J. Steger. 2002. *Commencement Bay Restoration Site Monitoring Work Plan for 2002*.

Ridolfi Inc. and Adolfson Associates, Inc. 2003. *Year 1 (2002) Monitoring Report for Commencement Bay Habitat Restoration Sites*. Prepared for the Commencement Bay Natural Resource Damage Assessment and Restoration Trustees. June.

Ridolfi Inc. and Adolfson Associates, Inc. 2001. *Long-Term Monitoring Work Plan for Habitat Restoration Sites in Commencement Bay*. Prepared for the Commencement Bay Natural Resource Damage Assessment and Restoration Trustees.

Simenstad, Charles A. 2000. *Commencement Bay Aquatic Ecosystem Assessments: Ecosystem-Scale Restoration for Juvenile Salmon Recovery*. Unpublished report prepared for City of

Tacoma, Washington Department of Natural Resources, and U.S. Environmental Protection Agency.

Tolt, J.S. 2000. *Community Effects of the Non-Indigenous Aquatic Plant Water Hyacinth (Eichhornia crassipes) in the Sacramento/San Joquin Delta, California*. M.S. Thesis, Fisheries Department, University of Washington.

U.S. Fish and Wildlife Service. 2003. *Fire Effects Monitoring Reference Guide: Daubenmire Method*. Available: <http://fire.r9.fws.gov/ifcc/monitor/RefGuide/daubenmire_method.htm>.

# FIGURES

## LIST OF FIGURES

# APPENDIX A

## Data Tables

## LIST OF DATA TABLES

# APPENDIX B

## Photos

# APPENDIX C

## Daubenmire Method

# APPENDIX D

## 2003 Fish Monitoring Field Reports

# APPENDIX E

## Photo Point Documentation

(Attached as CD-ROM)